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THESIS

AN INPUT TRANSLATOR FOR A
COMPUTER-AIDED DESIGN SYSTEM

by

Thomas H. Carson

June 1984

Thesis Advisor:

Alan A. Ross

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ABSTRACT (Continued)

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An Input Translator for a Computer-Aided Design System

by

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Lieutenant Commander, United States Navy
B.S., United States Naval Academy, 1971

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN COMPUTER SCIENCE

from the

NAVAL POSTGRADUATE SCHOOL
June 1984

ABSTRACT

The purpose of this thesis is to design and implement the input translator for the Computer System Design Environment, which is a computer-aided design system. The Computer System Design Environment is used to design real time controllers for a variety of purposes. The input translator will take an input, which has been developed in the prescribed language, CSDL, and with the aid of a partial syntax-directed editor, translate it into primitive list form. This form is used by the remainder of the system to select the best hardware and software components, as described in a set of realization libraries, to build the proposed controller.

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I. INTRODUCTION AND BACKGROUND

A. COMPUTER-AIDED DESIGN

Computers, as design tools, are beginning to touch every facet of our lives. We can turn on our television sets to see an advertisement for an automobile with a computer being used to aerodynamically design the body style of the car. Architects are using computers to assist in modern drafting and architectural design techniques [Ref. 1]. The potential for automating the design of many other products exists and research in all areas of computer-aided design (CAD) is continuing at a prolific rate.

While research in the areas of artificial intelligence may lead us someday to a computer which can, using natural language understanding, solve problems reserved for only humans today, current technology limits us to those problems where the computer relies on human expert input for a knowledge base. A knowledge base developed by human experts is used by the computer to derive a design much faster than a human and reduce the concern over the complexity of the process. The computer can maintain a large data base of components from which it can pick to satisfy a criteria as described by the designer. While not really creative, this system allows the mixing and matching, automatically, of components to produce the best combination available. The advantages to be gained are a decrease in the time it takes to complete the design process and error free results, while leaving the human designer to concentrate on the desired specification.

One of the most important features of such a system is its accessibility. The user interface must be one that meets the needs of the designer while remaining within the bounds of current technology. The interface must be user-friendly to the greatest possible extent. It is this particular portion of the problem which has given rise to the most debate and brought forth the widest range of possible solutions.

B. COMPUTER SYSTEM DESIGN ENVIRONMENT

The Computer System Design Environment (CSDE), under development at the Naval Postgraduate School in Monterey California, is one such computer-aided design system. It is based on the research contained in LtCol. Alan Ross's doctoral dissertation [Ref. 2]. Ross's work is an expansion and realization of the research conducted by M. N. Matelan [Ref. 3]. The first CSDE implementation is one in which real-time controllers (microprocessors) are designed based on a realization library (knowledge base) of current microprocessor technology. The system creates the problem statement in a syntax-directed editor, translates it into an intermediate form, selects a microprocessor realization from the library and generates the software and hardware component descriptions to implement the design. The components are used to select a processor volume or implementation. The volume checked to see if the timing constraints, set forth by the designer, can be achieved. If so, the monitor is generated and the output is formatted. The monitor produces the software and ancillary hardware to realize the correct strategy. If the timing constraints cannot be met, a new volume must be chosen and tested. The CSDE gives a designer the tools to derive the appropriate components that make up the controller, no matter what its task is to be.

Motivation and discussion of the CSDE are contained in [Refs. 2 , 3].

C. PREVIOUS WORK

The modules that make up the Computer System Design Environment are depicted in figure 1.1. Matelan described a Control System Design Language (CSDL) as the input language for this system [Ref. 3]. Using CSDL with a syntax-directed editor keeps the input details at a high-level of abstraction while completely describing the proposed design.

To fulfill the input requirements of block 1 in figure 1.1, a syntax-directed editor was designed and partially implemented as a result of Lt. Barbara Sherlock's thesis at the Naval Postgraduate School in 1983 [Ref. 4]. Lt. Sherlock's editor receives a high level input description of the problem from the designer, formats it and passes it to the input translator. This form is a combination of Matelin's CSDL and ADA, the Department of Defense sponsored design language. This language, as the basis for input to and output from the editor, follows the concept that the problem statement should not require the designer to be proficient in the details of a high level programming language. The translator, as its name suggests, translates the output from the editor into an intermediate form acceptable to the follow on CSDE processes. Its design and implementation are the subjects of this thesis. The optimizer and functional mapper (Blocks 3 and 4, Figure 1.1) exist as Fortran programs in the CSDE. The optimizer requires an 80 column format for its input which is a primitive list or the set of functions that the controller will perform, in an almost assembly-like language format. It is developed from the contingency and procedures sections of the design input statement. Hardware availability

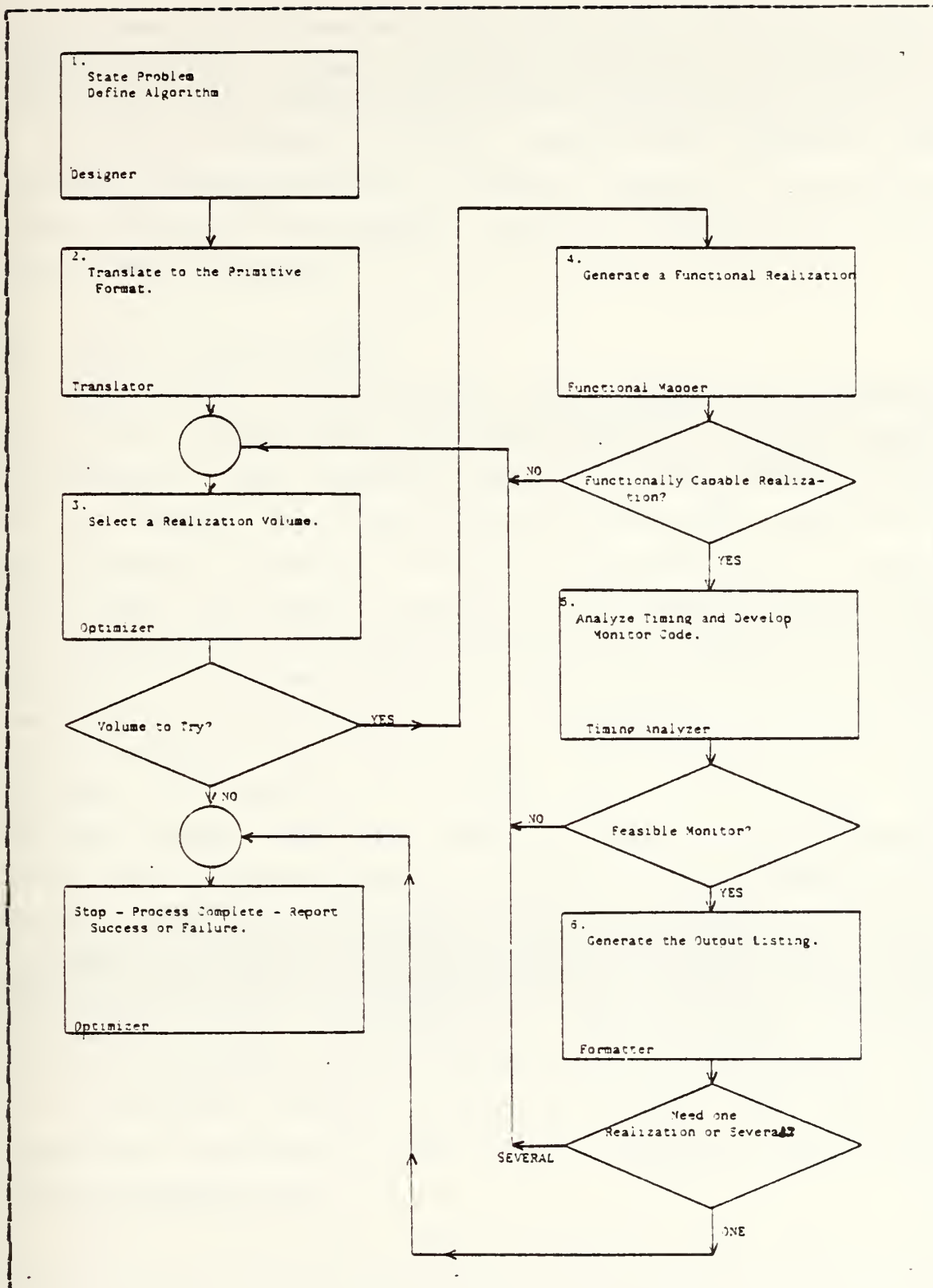


Figure 1.1 Computer System Design Environment.

prescribed this format when the CSDE was originally implemented by LtCol. Ross. Work is currently in progress to install both the design input and the realization library in a relational database, thereby updating the optimizing and mapping processes [Ref. 5]. But the basis of the input to these sections of the system, which is the primitive list, will remain the same.

D. SCOPE OF THIS THESIS

The purpose of this thesis is to design and implement the input translator for the Computer System Design Environment. The translator must take the problem statement, a design for a real time microprocessor controller, and translate it into a list of primitives and a symbol table which can then be mapped across a realization library to determine the most feasible components. Appendix A is an example of a problem statement in the Computer System Design Language developed by Matelan. In addition, the translator must produce a timing table which can be used by the timing analyser to determine a feasible monitor to control the complete device [Ref. 2]. The timing table is developed using the contingency section of the problem statement which contains the timing requirements for the problem.

The next chapter of this thesis describes the design considerations for the translator and provides the detailed discussion of its requirements. The following chapters discuss the implementation and testing of the translator and the conclusions reached during the work. In addition, Appendice D includes the code for the translator with appropriate documentation.

II. TRANSLATOR DESIGN

A. DESIGN REQUIREMENTS AND CONSTRAINTS

As previously discussed, the input translator can be thought of as one of several modules in the CSDE system. In the CSDE hierarchy, it lies between the designer and the optimizer. If we consider, for a moment, the module as a black box, then we can better describe its function. The input to the module is a specification, written by the designer, for a real time controller. While Lt. Sherlock, in her design of the input editor [Ref. 4], decided to produce a pseudo-ADA specification language as the output of the editor, the translator being designed by this author will use the Control System Design Language. If the ADA output was to be adapted, this language would have to be formalized and a grammar produced that is capable of being parsed. In addition, the pseudo-ADA provides no real advantage, as the specification must be parsed and the same output produced no matter what the language. Therefore, with the additional knowledge that the editor is the subject of a current thesis project which will return to the CSDL output, the decision was made to write the translator for that CSDL. A partial example of the CSDL description is contained in figure 2.1.

The output from the translator consists of a primitive list, a symbol table, and an application timing table. The primitive list is intermediate code which reflects the requirements of the input while the symbol table contains all input variables and their attributes. The application timing table contains the contingencies with their related tasks and all supplied timing values from the problem definition. This table is used during the timing analysis.

CONTINGENCY LIST

```
WHEN ALARM : 2MS,50US DO ALERT;  
EVERY 4MS : DO ENCODE;  
WHEN DATA_READY : 1300US DO SERIALIZE;
```

PROCEDURES

```
FUNCTION DATA_READY:  
  BINARY,1;  
  SENSE (BUFFER);  
  IF BUFFER /= OLDBUF THEN DATA_READY := 1 END IF;  
  EXIT DATA_READY;
```

Figure 2.1 A Partial Example of CSDL.

The requirements, then, exist for the input language, CSDL, to be analyzed to determine what method of translation is to be employed. In addition, the required output must be standardized among the system modules so the proper semantics can be developed for the translation process. Each of these issues will be discussed in detail in the following sections.

B. CSDL- THE INPUT LANGUAGE

A translator accepts a source program, written in a source language, and transforms it into an object program [Ref. 6]. A source language designed for use in a computer aided design system and utilized in CSDE is the Control System Design Language (CSDL), the origin of which was previously discussed. It is composed of an alphabet whose individual elements are called tokens and a grammar which expresses the rules governing the legal classes of token strings. The tokens can be further subdivided into terminals

and nonterminals. Terminals are the letters of the allowed alphabet while the nonterminals are representations of strings in the language which increase the expressive power. A partial example of the production rules for CSDL is contained in figure 2.2. The syntax for CSDL, which includes the alphabet and grammar, is contained in Appendix B.

```
<WHEN DO> ::= <QUALIFICATION> WHEN <NAME>
              <EPISODE TIMING> DO <TASK LIST>

<TASK LIST> ::= <NAME> / <TASK LIST> THEN <NAME>

<NAME> ::= *ID* / *ID* ( <EXPR LIST> ) /
            *ID* *NUMBER* : *NUMBER*
```

Figure 2.2 An Example of CSDL Syntax.

Different types of translating devices accept different languages classifications. To narrow the choice of translator designs, it must be determined which classification fits CSDL. Neither Matelan nor Ross, in their early work on CSDE, included this description [Refs. 2 , 3]. So, a brief review of language classification will assist in this determination. Chomsky distinguished four general classes of grammars [Ref. 7]. Without turning this section into a text on language theory, these are, from the most general to the most specific: unrestricted, context-sensitive, context-free, and right-linear. Context-sensitive and context-free are subsets of the unrestricted class, while the right-linear and two other grammars related to the right-linear

grammars, left-linear and regular, are all subsets of the context-free grammars. These classes allow us to define sentence recognizing machines which form the basis for translators. CSDL falls into the category of context-free grammars. This is the set which, in its production rules, has any string of terminals and nonterminals on the right-hand side of the production while the left-hand side is restricted to nonterminals only. The classes of right-linear, left-linear, and regular grammars restrict the order and appearances of terminals and nonterminals on each side of the production rules and CSDL does not fall into one of these categories. Context-sensitive grammars allow terminals as well as one nonterminal on the left-hand side of the production rules and, while CSDL does fit this category, the context-sensitive are a super-set of the context-free grammars, so this is not an issue when we try to develop the machines which can recognize CSDL.

Each of the phrase-structured grammar classes has an automaton associated with it. The right-linear grammars can be recognized and accepted by a finite-state automaton which consists of a finite set of states and a set of transitions between pairs of states. Each transition is associated with some terminal symbol. The context-sensitive grammars are recognized and accepted by a two-way, linear bounded automaton which is essentially a Turing machine whose tape cannot grow longer than the input string. And, finally, context-free grammars are recognized and accepted by a finite-state automaton controlling a push-down stack, with rules governing the operations on the stack [Ref. 6].

Matelan states that CSDL was created as a context-free grammar and inspection of the syntax contained in Appendix B confirms this [Ref. 3]. In order to recognize strings in the language and translate them into the prescribed primitive-list format a finite-state automaton with a push-down stack will be developed.

C. PARSER ALTERNATIVES

It was shown above that CSDL is a context-free grammar and a push-down automata will be required as the recognizer for strings in the language. Additional properties of CSDL must be investigated to further define the problem of parsing. In a context-free grammar each nonterminal can be expanded into some terminal string independently of its neighbors, and its expanded string essentially "pushes aside" its neighbors without interfering with their order in any way [Ref. 6]. But we do impose some ordering rule for the selection of the next nonterminal to replace, in a sentential form for a canonical derivation. The most common rules are left-most and right-most. In a left-most derivation, the left-most nonterminal in each sentential form is selected for the next replacement and in a right-most, the right-most nonterminal is selected. Most common programming languages are easily parsed from left to right, but with difficulty from right to left. Furthermore, algebraic operations are usually performed from left to right, by convention, so it is the order that will be considered. A top-down parse of some sentence, scanning from left-to-right through the string, corresponds to a left-most derivation while a bottom-up parse works from a given sentence upward toward the start symbol, in a left-to-right manner. [Ref. 6].

There are some rules governing the use of these two types of parsers which affect the choice of one for use in recognizing CSDL. Top-down recognition with a look-ahead of k symbols is only possible on a subset of the context-free grammars called $LL(k)$ grammars. Although it is not obvious whether a grammar is $LL(k)$, there is one property which is relevant in this discussion. An $LL(k)$ grammar has no left recursive nonterminals, i.e., a nonterminal A , such that $A \Rightarrow$

Aw for some w, a string in the language [Ref. 6]. It can be quickly determined by examining Production 17 in Appendix B that CSDL is left-recursive. In fact, it is full of recursion. There are algorithms for removing left-recursion in grammars and for a small grammar that would be the choice. But CSDL has 190 production rules and removing the extensive recursion would increase the grammar size an unacceptable amount. So top-down parsing will be discarded as a possible parsing method.

A bottom-up LR(k) parser is the other major type of recognizer under consideration. A grammar is said to be LR(k) if, for every derivation, the production $A \Rightarrow x$ can be inferred by scanning ux and at most the first k symbols of v in the following derivation step: $uAv \Rightarrow uxv$. The major advantage of this method is that an LR(k) parser can be constructed for any context-free grammar. This would eliminate the necessity to remove the left-recursion from CSDL.

There is one other major advantage in choosing a bottom-up LR(1) parser automaton. An automatic parser generator can construct, using a computer, the language specific tables that control the operation of the automaton. The LR package from Lawrence Livermore Laboratory [Refs. 8, 9] is such a system which constructs the tables. Having it available on the Vax 11/780 at the Naval Postgraduate School made the decision easy. It, also, has the advantages that the parsing routine is guaranteed to be correct, the CSDL grammar can be changed easily when necessary, and the resulting translator becomes simple and efficient. For the details as to how the package works see References 7 and 8.

D. PARSER STRUCTURE

The structure of the parser will follow the technique described by G.J. Myers in his book, Composite Structured Design [Ref. 10], and utilized in the design and implementation of an ADA pseudo-machine by Captain Alan Garlington in his thesis [Ref. 11]. The hierarchy for such a technique is

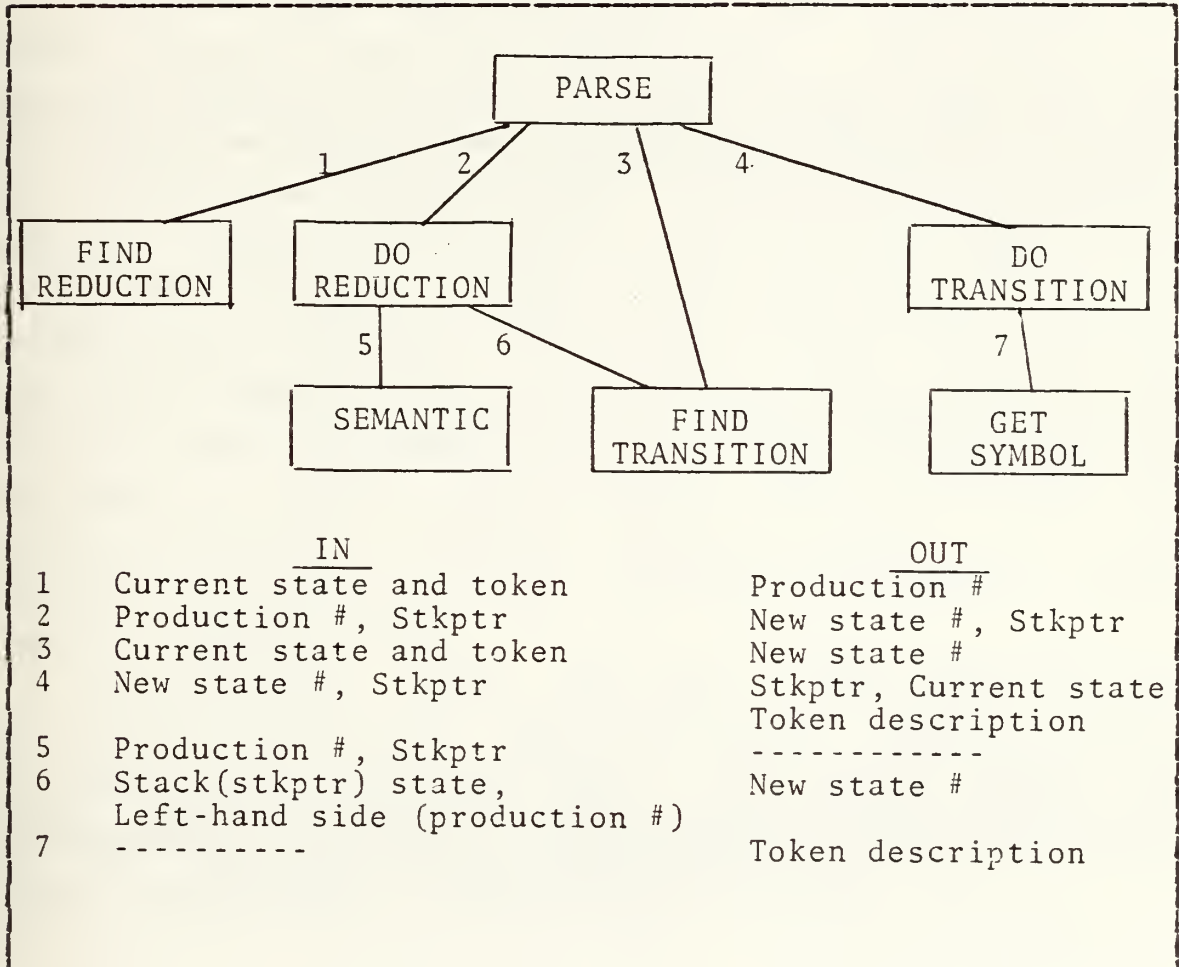


Figure 2.3 Parser Structure.

depicted in figure 2.3. The top module, PARSE, provides FINDREDUCTION with the current state and current look-ahead symbol. FINDREDUCTION returns a production number if any

reduction exists. PARSE then calls DOREDUCTION and the sequence is repeated. If no reduction exists, PARSE calls FINDTRANSITION to see if any transitions exist. DOTRANSITION accomplishes the transition and the routine repeats until a final state is reached. If no transition exists, an error is detected and the routine either attempts to recover or halts depending on the severity of the error.

The parser maintains two stacks, one to store the next token and one to store the current state. When DOREDUCTION provides SEMANTIC with the production number, the components of the production have been placed on the stack and SEMANTIC can take the proper action. This action could include adding a symbol to the symbol table with its appropriate parameters, calling an error routine, or nothing. After completing the semantic actions the items on the stack are removed by DOREDUCTION and the proper token replaces them. Various auxiliary procedures and error routines will be necessary to complete the translator. These procedures will include the input and output routines required to read the designers input and place the created primitives and symbol table in proper format.

The translator, thus, will take a CSDL description of the desired controller, check for errors, parse the input, and produce the primitive list, the symbol table, and application timing table. The implementation of the translator is discussed in the following chapter.

III. TRANSLATOR IMPLEMENTATION

A. LANGUAGE OF IMPLEMENTATION

The Computer System Design Environment was originally implemented in Fortran, with the system maintaining its data base on formatted punch cards for use in a batch environment. Feasible alternatives exist and have been investigated in subsequent research. CSDE is now installed in the Vax 11/780 at the Naval Postgraduate School, with interactive computing available in a variety of programming languages. However, it is still maintained, mainly, in Fortran. It has been shown to be conceptually feasible to represent the data base requirements of the CSDE by a relational model [Ref. 5]. Future intentions are to realize this concept on a data base management system such as Oracle, which is available on the Vax machine. The importance of this is that format, such as column numbers and location of data, and interface compatibility lose their importance and the relations between the data and the representations of the relations become major concerns.

An additional property required for the implementation language is maintainability. CSDL will not be static, as previously discussed. As hardware technology changes, the realization library will have to be updated and, accordingly, CSDL will have to be modified. This will result in an update to the translator, reflecting, possibly, such changes as new primitives. A high level familiar programming language will ease the burden of maintenance for future users.

Pascal is a high level programming language which supports the above requirements and, therefore, was chosen over the possible alternatives. Pascal is familiar to most programmers and, in fact, is the "first language" taught to new Computer Science students at the Naval Postgraduate School. In addition, it is easily understood by programmers conversant with other block-structured languages.

The modularity available with Pascal's procedures, functions, and high level constructs will provide maintainability. Each major function in the parser will comprise a Pascal procedure, making the main body of the program simple. Also, a section to be modified or updated is self-contained, and can be separately compiled and debugged following changes.

Perhaps the most important reason for selecting Pascal is the expected improvements in the CSDE system data base. When the libraries are placed in a relational database, and the designer's input must be mapped to a library in such a system, the data structures comprising the translator's outputs will require change. Pascal data structures are powerful and adaptable to a relational model, enabling this major modification to be completed without difficulty. Until such time as this occurs, the output will be of the form dictated by current system implementation. The details of this will follow.

B. TRANSLATOR INPUT

The input to the translator is the designer's requirements for a controller, written in the Control System Design Language, an example of which is contained in Appendix A. At this writing, a partial syntax-directed editor is under development which will create, based on the designer's ideas, the input in syntactically correct form. No

conceptual basis for the storage or file format of the input has been previously discussed, so several assumptions were made to enable production of the translator. Since the program is to be written in Pascal and reside as a member of the larger system, the CSDE, a simple file containing the CSDL problem description, which is read by the translator, will be utilized as the method of input. The file will be a text file with the only formatting restrictions being those imposed by the syntax of CSDL, the language being parsed. While this method of input will, currently, require some hands on system manipulation during run time, it is envisioned that a system macro can easily be developed at a later date to automate the process.

It is intended that the input be provided to the translator in syntactically correct form. However, as mentioned above, the means for this is not yet implemented. As example problem statements and test cases have been generated to exercise the translator, a requirement has developed for syntax error detection. This requirement can be eliminated and the ensuing code removed upon completion of the editor.

C. PRINCIPAL PROCEDURES AND DATA STRUCTURES

The parser was summarized at a high level of abstraction in Chapter 2 of this thesis. This section will point out the important procedures and data structures employed by the translator. The supporting functions which complete the translator are described as they appear in the program in Appendix D.

The tables produced by the automatic parser generator, which control the operation of the parser, are placed in arrays. The array sizes were set in program constants and would be modified if a change to CSDL caused a modification

to the tables. In addition, the symbol table, the state and lookahead stacks, and the temporary and constant lists are all implemented as arrays of records. Each record contains such information as the type and precision of the variable or constant and a pointer to the next record in the list. With the continuous manipulation of these data structures, such as pops and pushes on the stacks as well as the requirement for access to each member of each list, it was determined that this implementation allowed the maximum degree of flexibility. Also, the size of each data structure was described by a program constant, in order to improve maintenance. A limit might change in a situation where a controller design required a large number of input and output signals or internal variables, exceeding the maximum allowed for a stack.

Four sections conceptually comprise the translator program. The first is the initialization sequence, comprised of the procedure INITIALIZE and supporting functions. This section sets the initial values for all program variables and initializes the temporary and constant lists as well as the input symbol table to null values. It also establishes the SYMTABLE, which is a list containing all reserved words in CSDL, each located by a pointer. This table is used in the program to check each input token to determine whether it is a reserved word, identifier, or operator. Additionally, INITIALIZE includes the procedures for sending the generated primitive list, symbol table, and scratch pad to output files.

The next section is the actual parsing routine, comprised of the procedures PARSE, FINDREDUCTION, DOREDUCTION, FINDTRANSITION, DOTRANSITION, and their supporting procedures and functions. This sequence of code, essentially, repeats itself, looking at each input token, retrieved by GETSYM, and attempts to move through the

required production until a final state is reached. The tokens are placed on the stack and if a reduction can be performed, control moves to the semantic portion of the program. If one cannot be done, the sequence finds the transition and continues movement through the production rule, getting the next input symbol, with the stack unchanged. If no transitions exist, an error is present in the input.

When a reduction number, which corresponds to a production number in the CSDL grammar, is found, the program sequences to the third main section which contains the semantic operations for the program. It includes the procedures SEMANTIC and SEMANTIC1. These are two large case statements which, for each production, do the proper stack operations and send the output information to the procedures in the initialization section to be formatted and filed. The semantic operations are called from within DOREDUCTION, but really comprise a separate module within the structure of the translator.

The last section of the translator is the set of procedures comprising the error handling routines. This includes procedures PRINTERRORS, RECOVER, ERROR, and PRINTLINERRORS. The parsing routine attempts to recover, using the procedure of the same name, from an error while documenting it to the user. If the parser cannot recover, the program will halt and print the complete list, in a file, of the errors noted prior to the crash. This error handling sequence can be eliminated from the translator, as previously noted, on completion of a syntax directed editor, which would ensure error-free input.

D. TRANSLATOR OUTPUT

1. Primitive List

The primary output of the translator is the primitive list, a sample of which is contained in figure 3.1. This list of primitives is similar to a set of macros with

```
P 1s.generated for:DATAA
P 2s.proc      {DATAA:}
P 3s.sensecond {FLGA:1}
P 4s.eq        {@T01,FLGA,@C01:8,1,8)
P 5s.jmpf      {@T01,@01:8)}
P 6s.assign    {DATAA,@C01:1,8)
P 7s.loc       {@01:)}
P 8s.exitproc  {DATAA:)}
```

Figure 3.1 A Sample of the Primitive List.

the operands and attributes corresponding to parameters. It is converted by the Optimizer module, in the CSDE, to the internal format required by succeeding modules [Ref. 2].

In the initial implementation of CSDE there was no front end, i.e., the modules for the designer input and translation to intermediate form did not exist. Therefore, the information required in each primitive was hand generated and formatted by column number so it could be inputted in batch form as a card image file. Because the information is still required in the same format, the output, containing the primitive list and called PRIMFILE, was set up in an identical manner. Each primitive is one line and spaces were added to emulate the blank columns on a punch card. The name of the primitive appears first (software primitives preceded by s., hardware by h.). This is followed by the operand list and selection list (if any) separated by a colon [Ref. 16].

The primitive list, also, contains the design criteria, preceded by d., which allows the designer to specify the order of consideration of the realization volumes. The generation of many realizations can also be requested, each of which is presented along with its chip count and power requirements. The final portion of the primitive list is the application timing table, with each line preceded by a beginning A. This table includes the timing constraints and associated requirements. Further details concerning the information present in each column in the sections of the primitive list are contained in Reference 2 and, therefore, will not be discussed here.

The primitive names, such as eq and mult, were chosen to correspond as closely as possible to the operation suggested, but the names in the realization volumes must be identical to the ones emitted by the translator for the CSDE to function. They are easily modified in the semantic portion of the program if required. However, new operations will dictate a modification to the CSDL grammar with additional productions and semantic rules.

2. Symbol Table

The concept of a symbol table, for use by succeeding modules in the CSDE, is a result of this thesis. With the format required in the primitive list, it is difficult for the modules to look up, during the mapping, the attributes such as type, precision, value, and technology for controller variables and constants. It is thought that if this information were available in an easily read form, it would increase the speed of the realization process and raise the level of system efficiency. The functional mapper could read the symbol table first, and generate memory requirements for the controller prior to addressing the operations.

A symbol table can take as many forms as there are formats for a file. The data structure used to hold the information is also arbitrary. At the time of this writing, no decision has been made as to the ideal implementation. So, the information will be dumped into a file in the same format as the primitive list and can later be changed. This information includes all variables with their initial value and precision, all required memory locations, and all constants. In addition, the input and output ports with the expected signal names, technology, and precision are included for possible use. The code to format the symbol table can either be written in a separate small routine to be installed as a system module, or could be added to the translator. Whichever the case, a decision in this matter may well come in time for the code to be included in the final version of the translator for this thesis, in which case it will be reflected in the example symbol table in the appendices.

3. Scratch Pad

A scratch pad file developed naturally as the translator was designed and implemented. Used initially for output, it significantly aided the debugging and verifying of the processes. Error routines, mentioned previously, send error diagnostics to this file. Traces of parser execution which were developed out of necessity as part of the debugging process also needed an output medium. Because of this, the scratch pad became a formal part of the translator. This file, TRANSLATE, is a text file, with no particular format, containing information which can be helpful to the user. If an error is detected in the input, the diagnostic, which traces the error, will appear here, with comments as to possible corrective action.

In addition, three toggles have been included which provide, if desired, 3 types of traces of program execution. TRACEPARSE will trace the parsing action, providing the transition and reduction numbers as the parser moves through the input. TRACETOK provides the input tokens, one at a time, as they are read. PRINTTABLE displays the controller symbol names with their attributes. These toggles are activated by including "--#" followed by a toggle name at the head of the input file. More than one toggle per execution can be utilized, but the ensuing report becomes difficult to comprehend.

IV. TESTING AND VALIDATION

A. THEORY OF TESTING

The theory of software testing is a difficult problem and the subject of extensive research. Preliminary reports from this research indicate varying effectiveness. Dijkstra says that debugging can only show the presence of errors, but never their absence [Ref. 12]. It is commonly agreed that program testing cannot assure program "correctness" except under special circumstances. But the debate over Dijkstra's statement continues because others have developed theorems which challenge his reasoning [Ref. 13].

The most important factor in testing is to have a well-understood goal for the testing process. In the case of the input translator, proving correctness was not at issue. The algorithm for the parser is well proven to be a correct one [Ref. 9], so the detection of bugs in the program was the goal. Methods of testing include top-down versus bottom-up, static versus dynamic, white box versus black box, and other less known systematic approaches. In bottom-up testing, the idea is to build the program with proven (bug free) components, while top-down begins with tests of the highest level using stubs to simulate the activity of the lower level modules. Static testing attempts to demonstrate the truth of an allegation, i.e., it roughly corresponds to bench-testing a power-driven device without applying power, and dynamic testing seeks to exercise a program in a controlled and systematic way. The white box testing approach is, knowing any part of the software system is present for some specific reason, then relating each piece of a software system to the requirement it fulfills. The black box method

is an extensive testing approach which attempts to demonstrate the presence of function by concentrating on the exterior specifications of the software system [Ref. 14].

Just these brief examples illustrate the fact that software testing is not a well-defined science. The primary reason for this is that the concern for software reliability is relatively new. Only in the past decade has any notable effort been expended in understanding how a program can be proven correct or demonstrated to be reliable.

In selecting possible approaches to establish the reliability of the input translator, a combination of methods was determined to be the best. As previously noted, program correctness is not the objective. Also, the individual modules were completely debugged as they were built. So the problem reduces to ensuring the function between the input and output is such that the correct output is realized for each possible input. This is a black box methodology, but, since the program is to be exercised as a whole, the concept of dynamic testing also applies. The following section discusses the results of this testing and validation.

B. TEST RESULTS

Functional testing, a form of dynamic testing, involves the testing of a system over each of the different possible classes of input, the testing of each function implemented by the system, and the generation of test output in each of the possible output classes [Ref. 15]. This is the methodology that was employed in the testing of the input translator.

The CSDL input is divided into 5 parts which are IDENTIFICATION, DESIGN CRITERIA, ENVIRONMENT, PROCEDURES, and CONTINGENCIES. Each of these sections was examined in detail to determine the finite set of permutations in structure and content, as set forth by the CSDL grammar.

These possibilities formed the basis for test cases to be used in exercising the input translator. Due to its complexity, the PROCEDURES section received the most attention, but each part is discussed, in terms of the test results, below.

The IDENTIFICATION section, an example of which is contained in figure 4.1, consists of 3 character strings

```
IDENTIFICATION
DESIGNER: "Thomas H. Carson"
DATE: "10 April 1984"
PROJECT: "Start Malfunction Controller"
```

Figure 4.1 IDENTIFICATION Section of the Input.

which make up a portion of the documentation for the system. The strings are not parsed by the input translator, just simply read and ignored. This section is optional, as are they all, and the parser performs no other action on it.

The DESIGN CRITERIA, an example of which is contained in figure 4.2, allows the the user to specify the metric and number of monitors and volumes to be employed in the mapping process, the next module in the CSDE system. The metric is one of 3 choices, all character strings, while the monitors

```
DESIGN CRITERIA
METRIC FIRST;
VOLUMES 1;
MONITORS 1;
```

Figure 4.2 DESIGN CRITERIA Section of the Input.

and volumes are integer values. The parser reads each of these and checks for correctness in terms of value. It then reformats the information and places it in a special portion

```
3d:FIRST      :      1:      1:
```

Figure 4.3 Primitive List Form of the DESIGN CRITERIA.

of the primitive list. The possible alternatives were exercised and the corresponding correct output was generated, an example of which is contained in figure 4.3.

The ENVIRONMENT section, an example of which is contained in figure 4.4, contains the variable declarations for the input. It has 4 parts which are: procedure declarations, input signals, output signals, and duplex signals. While each of the above is optional, the controller will have to sense at least one input and emit one output to have some function. Each declaration can have its name, structure, precision, initial value, or the technology associated

```
ENVIRONMENT
  INPUT: RPM,8,TTL; FIRE SENSE,1,TTL;
        OIL PRES,8,TTL; END INPUT;
  OUTPUT: SDT,1,TTL; SD2,1,TTL;
        FIRE EXT,1,TTL; END OUTPUT;
  ARITHMETIC: STAG FLG,1; END ARITHMETIC;
```

Figure 4.4 ENVIRONMENT Section of the Input.

with it. The type of declaration decides which and how many of the attributes each variable will have. For the internal

program variables, in the ARITHMETIC section, the translator generates a system variable primitive and for each of the signals it produces the associated software primitive. Again, while the translator is parsing the structure of the input, the real work done is reformatting the names and their associated attributes into the appropriate primitive. No errors could be detected in exercising the program over this

```
4s.inputport {RPM,TTL:8)
5s.inputport {FIRE SENSE,TTL:1)
6s.inputport {OIL PRES,TTL:3)
7s.outputport {FIRE_EXT,TTL:1)
8s.var       {STAGFLG:1,0)
```

Figure 4.5 Primitive List Form of the Input.

portion of the input. An example of the output generated by the above example is contained in figure 4.5.

The PROCEDURES section contains the functions and tasks which establish the purpose of the controller being realized. The differences between functions and tasks are: functions are allowed only one basic statement and return a value while tasks allow multiple statements and perform a job. The key to both is the basic statement which is one of several types seen in most programming languages. The alternatives are: if-then, while-do, for loop, assignment, data input, data output, perform task, and wait. The only ones that might not be familiar are the "perform task" and "wait". "Perform task" allows for nested procedures and the "wait" statement causes the program to suspend itself for a prescribed period of time. An example of a task is contained in figure 4.6.


```

TASK OVRSPD;
  IF START SWIT THEN
    SENSE (RPM);
    SD5 := 0;
    IF RPM > 74 THEN SD5 := 1; END IF;
    ISSUE (SD5);
  END IF;
END OVRSPD;

```

Figure 4.6 PROCEDURES Section Input Example.

This section is where the parser really does its work. It must parse each statement in the procedure and generate an appropriate section of primitives, including temporaries, assembly-language-like software primitives and labels, which fulfill the intent of the statement. Each of the basic statements was exercised through the translator without any error detection, but because of the increased complexity of this section, 100% reliability cannot be confirmed. To do so would require a technique such as path testing. This requires that every logical path through a program be tested at least once. Another possibility is to construct test data which causes each branch in the program to be traversed [Ref. 15]. Algorithms for such testing exist, but the problems with each are the excessive time, CPU service, and output verification required. Therefore, complete path or branch testing was not attempted. However, the author's confidence in the correctness, after the testing that was conducted, is 100%. An output produced from the above input example is contained in figure 4.7.

The CONTINGENCY LIST section, an example of which is contained in figure 4.8, sets up the flow and timing for the controller by establishing how often each procedure should be executed. There are 4 types of statements allowed in this section: when-do, at time, simple do, and the every.


```

106t.generated for:OVRSPD
107s.proc      (OVRSPD:)
108s.jumpf     (START SWIT,@12:1)
109s.sensecond (RPM:8)
110s.gt        (@T01,RPM,@C07:8,8,8)
111s.jumpf     (@T01,@13:8)
112s.assign    (SD5,@C01:1,8)
113s.loc        (@13:)
114s.issuevent (SD5:1)
115s.loc        (@12:)
116s.exitproc  (OVRSPD:)

```

Figure 4.7 Primitive List Form of the PROCEDURES Section.

While the parsing action for these statements, basically just a reformatting routine, is simple, problems developed in

```

CONTINGENCY LIST
WHEN RESET SWIT:100MS DO INIT;
EVERY 1000MS DO CLOCK;
EVERY 100MS DO OVRSPD;

```

Figure 4.8 CONTINGENCY LIST Input Example.

determining what the format in the primitive list should be. For consistency, each was treated the same with blanks left in the columns in the "simple do", "every", and "at time" statements where a contingency name appears in the "when-do" statement. Examination of the example output in figure 4.9 and its comparison with the input example above will clarify this point. Alternative entries, such as the word "each", to replace the blanks are under consideration. The decision, based on the requirements of the functional mapper, will not occur prior to the submission of this thesis. Therefore, it is not possible to establish complete

A	1	:	RESET_SWIT	:	INIT	:	MS:	100,	0,	0,	0,	0
A	2	:		:	CLOCK	:	MS:	1000,	0,	0,	0,	0
A	3	:		:	OVRSPD	:	MS:	100,	0,	0,	0,	0

Figure 4.9 Primitive List Form of the CONTINGENCY LIST.

correctness in this section. The program does act according to its given requirements but the possibility exists for these to change and, at that time, the section will have to be reverified.

Only the primitive list has been discussed above as program output. The translator also generates a symbol table and a scratch pad. Since the symbol table is unformatted, testing established only that the required information was present. The scratch pad is not a functional member of the CSDE and, therefore, was not tested. The error-checking routines within the translator were tested in so far as they were used in creating correct input file for the testing described above. This was considered adequate due to the impending completion of a syntax-directed editor for composing the CSDL input for the translator.

The input translator was built bottom-up in modular form. This methodology and the use of the automatically generated driver for the parsing routines were significant reasons for the relatively error-free results obtained during the testing of the translator as a whole.

V. CONCLUSIONS AND RECOMMENDATIONS

A. PROGRAM MAINTENANCE

The use of the automatic parser generator in providing the control tables for the translator allows the maximum degree of flexibility for program maintenance. The resulting main program is modular and space efficient, with anticipated changes, such as new emissions from the semantic routines, easily included in the system.

The most obvious portion of the system which will undergo modification is the CSDL grammar. Matelan states there is no capability in CSDL for notational extensibility, nor should there be [Ref. 16]. He points out it is doubtful that the average user can design extensions that will cause less harm than good and the provision of a good macro capability and extendable function/task libraries are preferred. This author disagrees. The advantage of using the parser generator is that a new set of tables can be produced for a modified CSDL with virtually no disturbance to the translator. The changes to the grammar must be consistent with the rules governing LL(1) grammars, but such modifications as the inclusion of new tokens or reserved words is within the capability of advanced program language students. In addition, to keep CSDL static, using the function/task libraries to realize new primitive operations as they become technologically feasible, only results in a less efficient controller. It could lead, in the worst case, to the inability to utilize the latest hardware technology available for controller design. This was most certainly not the intent.

One particular change to CSDL needs immediate attention. Many controllers require an analog input or output signal. Matelan, in his work, makes the assumption that analog information must be converted to a digital signal before it reaches the interface [Ref. 16]. If we have the ability to modify CSDL, this is no longer a complex issue. One possibility is to add a new input/output signal type with the CSDE calling for an A/D-D/A converter when this type is mapped to a library.

B. RECOMMENDATIONS FOR CSDE

The flow of information between modules in CSDE, prior to the impending completion of the designer and translator modules, is consistent. Since the system was implemented in Fortran and resides on one machine, there is no problem. But with the completion of the translator, the subject of this thesis, and the designer module having the same time schedule, the problem of interfaces becomes significant. The translator is written in Pascal and, while the output is a simple text file, the information flow will not be as it should. In addition, the designer module is being written in the "C" programming language which will generate, possibly, further interface problems. It is therefore recommended that the CSDE system be incorporated, as quickly as possible, into a data base management system such as Oracle. This was previously discussed in Chapter 3 of this thesis and the design of the data base was the subject of earlier research [Ref. 5]. This research pointed out that this redesign of CSDE should help streamline the operation and eliminate any complex programming schemes that were built out of necessity in earlier work. This concept will eliminate, completely, the interface problems, as the information will be input to and accessible from the database as

it passes from one module to the next. An overall improvement in system documentation, efficiency, and usability should result while, at the same time, allowing each module to maintain its individuality and function.

C. SUMMARY

In completing the design and implementation of the input translator, the objective of this thesis has been accomplished. The translator has been tested and fulfills the function required of the module in the Computer System Design Environment [Ref. 2]. The additional features added to the translator include an option to monitor the execution sequence in a variety of tracing modes and extensive error checking. While not considered integral parts of the program, these features were useful in its design and testing. As the CSDE evolves, these features might become superfluous, at which time they could be eliminated. But the information provided by the features should be considered prior to that decision.

The design methodology employed in the production of the translator was not innovative, but it allowed the program to be simple and straightforward. The use of the automatic parser generator was a time saver and proved to be a tool which will allow for the ease of future program maintenance as no other could. In one sense, we could say, while generating a module for a computer aided design system, a computer aided programming tool was central in the development.

The translator will reside in the CSDE on the VAX 11/780 VMS operating system. It is a Pascal program with the source and object code available under the filename "CSDL". The user instructions have been fully covered in the previous sections of this thesis.

APPENDIX A
TRANSLATOR INPUT EXAMPLE

IDENTIFICATION

DESIGNER: "Alan Ross"

DATE: "12-23-83"

PROJECT: "Dial Process Control Application"

DESIGN CRITERIA

METRIC FIRST;

VOLUMES 8;

MONITORS 8;

ENVIRONMENT

INPUT: CONSIN,8,TTL; CONST,8,TTL; FLGA,1,TTL; PINA,8,TTL;
FLGB,1,TTL; PINB,8,TTL; END INPUT;

OUTPUT: VA,8,TTL; VB,8,TTL; END OUTPUT;

ARITHMETIC: KCA,8; KCB,8; CNT_B,3; ITIA,8; ITIB,8; AINT,8;
TDA,8; TDB,8; BINT,8; VSA,8; VSB,8; BDIFF,8;
PSA,8; PSB,8; CONPTT,8; EA,8; EB,3; KPIA,8;
EA1,8; EA2,3; EB1,8; EB2,8; KPIB,8;
END ARITHMETIC;

PROCEDURES

FUNCTION DATA_A:

BINARY,1;

SENSE (FLGA);

IF FLGA = 1 THEN DATA_A := 1; END IF;

END DATA_A;

FUNCTION DATA_B:

BINARY,1;


```

SENSE (FLGB);
IF FLGB = 1 THEN DATA_B := 1; END IF;
END DATA_B;

FUNCTION BCNT:
  BINARY, 1;
  IF CNT_B >= 4 THEN BCNT := 1; END IF;
END BCNT;

TASK AFIX;
  ARITHMETIC: ADIFF, 8; END ARITHMETIC;
  SENSE (PINA);
  EA := PINA*KCA - PSA;
  ADIFF := (3*EA - 4*EA1 + EA2)*5;
  AINT := AINT + EA/KC;
  VA := VSA + KCA*(EA + ITIA*AINTE + IDA*ADIFF);
  ISSUE (VA);
  DATA_A := 0;
  EA2 := EA1;
  EA1 := EA;
END AFIX;

TASK B_CALC;
  SENSE (PINB);
  EB := PINB*KCB - PSB;
  BDIFF := (3*EB - 4*EB1 + EB2)*10;
  BINT := BINT + EB/KCB;
  CNTB := CNTB + 1;
  DATA-B := 0;
END B_CALC;

TASK BFIX;
  CNTB := 0;
  VB := VSB + KCB*(EB + ITIB*BINT + IDB*BDIFF);
  ISSUE (VB);
END BFIX;

```


FUNCTION CONFLG:

BINARY, 1;

SENSE (CONSIN);

IF CONSIN > 0 THEN CONFLG := 0; END IF;

END CONFLG;

TASK CHGCON;

SENSE (CONST);

IF CONPTT = 1 THEN KCA := CONST; END IF;

IF CONPTT = 2 THEN ITIA := 1/CONST; END IF;

IF CONPTT = 3 THEN TDA := CONST; END IF;

IF CONPTT = 4 THEN VSA := CONST; END IF;

IF CONPTT = 5 THEN PSA := CONST; END IF;

IF CONPTT = 6 THEN AINT := CONST; END IF;

IF CONPTT = 7 THEN KCB := CONST; END IF;

IF CONPTT = 8 THEN ITIB := 1/CONST; END IF;

IF CONPTT = 9 THEN TDB := CONST; END IF;

IF CONPTT = 10 THEN VSB := CONST; END IF;

IF CONPTT = 11 THEN PSB := CONST; END IF;

IF CONPTT = 12 THEN BINT := CONST; END IF;

END CHGCON;

CONTINGENCY LIST

WHEN DATA_A :100MS DO AFIX;

WHEN DATA_B :50MS DO B_CALC;

WHEN BCNT :100MS DO BFIX;

WHEN CONFLG DO CHGCON;

APPENDIX B
FORMAL SYNTAX OF CSDL

TERMINALS

NONTERMINALS

1. (
2.)
3. *
4. **
5. *ID*
6. *NUMBER*
7. *STRING*
8. +
9. '
10. -
11. .
12. /
13. /=
14. :
15. :=
16. ;
17. <
18. <=
19. =
20. ==
21. =>
22. >
23. >=
24. AND
25. ARITHMETIC

84. <AOP>
85. <ARITHMETIC BODY>
86. <ARITHMETIC DEC>
87. <ARITHMETIC SPEC>
88. <ASSIGNMENT STMT>
89. <AT TIME>
90. <B1>
91. <B2>
92. <BASIC STMT>
93. <BINARY BODY>
94. <BINARY DEC>
95. <BINARY PRECISION>
96. <BINARY SPEC>
97. <CHARACTER REP LIST>
98. <CHARACTER REP>
99. <CODE DEC LIST>
100. <CODE DEC>
101. <CODE ID>
102. <CODE SPEC>
103. <CODE VAR SPEC>
104. <CONTINGENCY DEF>
105. <CONTINGENCY LIST>
106. <CONTROL SYSTEM DESIGN>
107. <DATA INPUT>
108. <DATA OUTPUT>

26. ASCII6	109. <DEC GP>
27. ASCII7	110. <DEC>
28. AT	111. <DECIMAL PRECISION>
29. BCD	112. <DESIGN CRITERIA>
30. BINARY	113. <DUPLEX SPEC>
31. CODE	114. <ENVIRONMENT SECTION>
32. CONTINGENCY	115. <EPISODE TIMING>
33. COST	116. <EVERY>
34. CRITERIA	117. <EXPR LIST>
35. DATE	118. <EXPRESSION>
36. DESIGN	119. <EXP_2>
37. DESIGNER	120. <EXP_3>
38. DO	121. <EXP_4>
39. DUPLEX	122. <FACTOR>
40. EBCIDIC	123. <FOR HEAD>
41. ECL	124. <FOR LOOP>
42. END	125. <FORMAL PARAM LIST>
43. ENVIRONMENT	126. <FUNCTION>
44. EVERY	127. <FUNCTION_HEAD>
45. FIRST	128. <ID LIST>
46. FOR	129. <ID SECTION>
47. FROM	130. <IF HEAD>
48. FUNCTION	131. <IF THEN>
49. H	132. <INITIAL VALJE>
50. IDENTIFICATION	133. <INPUT SPEC>
51. IF	134. <LABELED STMT>
52. ITL	135. <LEFT PART LIST>
53. IN	136. <LIST BODY>
54. INPUT	137. <MAX LOOP COJNT>
55. ISSUE	138. <METRIC>
56. LIST	139. <MOP>
57. M	140. <NAME>
58. METRIC	141. <NU>
59. MONITORS	142. <NUMBER LIST>
60. MS	143. <OUTPUT SPEC>

61. NOT	144. <PERFORM TASK>
62. NS	145. <PERIOD>
63. OR	146. <PI>
64. OUTPUT	147. <PRIMARY>
65. POWER	148. <PROC DEC GP>
66. PROCEDURES	149. <PROC DEC>
67. PROJECT	150. <PROC GP>
68. S	151. <PROC SECTION>
69. SENSE	152. <PROC>
70. TASK	153. <QUALIFICATION>
71. TERM	154. <RANK>
72. THEN	155. <RELATION>
73. TO	156. <RELATIONAL GP>
74. TTL	157. <ROE>
75. UNTIL	158. <SIMPLE DO>
76. US	159. <SIMPLE EXP>
77. VARIABLES	160. <STMT GP>
78. VOLUMES	161. <STMT>
79. WAIT	162. <STRUCTURE>
80. WHEN	163. <SYSTEM GOAL SYMBOL>
81. WHILE	164. <TASK LIST>
82. {	165. <TASK>
83. }	166. <TASK_HEAD>
	167. <TECHNOLOGY>
	168. <TERM>
	169. <TIME MEASURE>
	170. <TIME>
	171. <TIMED BLOCK>
	172. <TIMED_BLOCK_HEAD>
	173. <TRANSMISSION BODY>
	174. <TRANSMISSION DEC>
	175. <WAIT UNTIL>
	176. <WAIT>
	177. <WAIT_HEAD>
	178. <WHEN DO>

- 179. <WHILE DO>
- 180. <WHILE HEAD>
- 181. <WHILE>
- 182. <ZOPT PROC DIC GP>

THE PRODUCTIONS

- 1. <SYSTEM GOAL SYMBOL> ::= END <CONTROL SYSTEM DESIGN> END
- 2. <AOP> ::= 3. / -
- 4. <MOP> ::= *
- 5. / /
- 6. <RELATIONAL OP> ::= <
- 7. / <=
- 8. / =
- 9. / >
- 10. / >=
- 11. / /=
- 12. <PRIMARY> ::= *NUMBER*
- 13. / *STRING*
- 14. / <NAME>
- 15. / (<EXPRESSION>)
- 16. <FACTOR> ::= <PRIMARY>
- 17. / <FACTOR> ** <PRIMARY>
- 18. <TERM> ::= <FACTOR>
- 19. / <TERM> <MOP> <FACTOR>
- 20. <SIMPLE EXP> ::= <TERM>
- 21. / <AOP> <TERM>
- 22. / NOT TERM
- 23. / <SIMPLE EXP> <AOP> <TERM>
- 24. <RELATION> ::= <SIMPLE EXP>
- 25. / <SIMPLE EXP> <RELATIONAL OP> <SIMPLE EXP>


```

26. <EXP_4> ::= <RELATION>
27.          / <EXP_4> AND <RELATION>
28. <EXP_3> ::= <EXP_4>
29.          / <EXP_3> OR <EXP_4>
30. <EXP_2> ::= <EXP_3>
31.          / <EXP_2> => <EXP_3>
32. <EXPRESSION> ::= <EXP_2>
33.          / <EXPRESSION> == <EXP_2>
34. <EXPR LIST> ::=
35.          / <EXPRESSION>
36.          / <EXPR LIST> , <EXPRESSION>
37. <IF THEN> ::= <IF HEAD> THEN <STMT GP> END IF
38. <IF HEAD> ::= IF <EXPRESSION>
39. <WHILE DO> ::= <WHILE HEAD> DO <STMT GP> END WHILE
40. <WHILE HEAD> ::= <WHILE> <EXPRESION> : <MAX LOOP COUNT>
41. <WHILE> ::= WHILE
42. <FOR LOOP> ::= <FOR HEAD> DO <STMT GP> END FOR
43. <FOR HEAD> ::= FOR *ID* FROM <EXPRESSION> TO
          <EXPRESSION> : <MAX LOOP COUNT>
44. <PERFORM TASK> ::= *ID*
45.          / *ID* ( <EXPR LIST> : <ID LIST> )
46. <MAX LOOP COUNT> ::= *NUMBER*
47. <LEFT PART LIST> ::= <NAME> :=
48.          / <LEFT PART LIST> <NAME> :=
49. <ASSIGNMENT STMT> ::= <LEFT PART LIST> <EXPRESSION>
50. <DATA INPUT> ::= SENSE ( <NAME> )

```


51. <DATA OUTPUT> ::= ISSUE (<NAME>)
 52. <TIME MEASURE> ::= H
 53. / M
 54. / S
 55. / MS
 56. / US
 57. / NS
 58. <PERIOD> ::= *NUMBER* <TIME MEASURE>
 59. <TIME> ::= <PERIOD>
 60. / <TIME> <PERIOD>
 61. <TIMED BLOCK> ::= <TIMED_BLOCK_HEAD> DO <STMT GP> END IN
 62. <TIMED_BLOCK_HEAD> ::= IN <PERIOD>
 63. <WAIT> ::= WAIT <PERIOD>
 64. / WAIT <EXPRESSION> : <PERIOD>
 65. <WAIT UNTIL> ::= <WAIT_HEAD> <EXPRESSION> : <PERIOD>
 66. <WAIT_HEAD> ::= WAIT UNTIL
 67. <BASIC STMT> ::= <IF THEN>
 68. / <WHILE DO>
 69. / <FOR LOOP>
 70. / <PERFORM TASK>
 71. / <ASSIGNMENT STMT>
 72. / <DATA INPUT>
 73. / <DATA OUTPUT>
 74. / <TIMED BLOCK>
 75. / <WAIT>
 76. / <WAIT UNTIL>
 77. <LABELED STMT> ::= *ID* : <BASIC STMT>
 78. <STMT> ::= <BASIC STMT>


```

79.          / <LABELED STMT>

80. <STMT GP> ::= <STMT> ;

81.          / <STMT GP> <STMT> ;

82. <PROC DEC> ::= <BINARY SPEC>

83.          / <ARITHMETIC SPEC>

84.          / <CODE SPEC>

85.          / <CODE VAR SPEC>

86. <INPUT SPEC> ::= INPUT : <TRANSMISSION BODY> END INPUT

87. <OUTPUT SPEC> ::= OUTPUT : <TRANSMISSION BODY>
      END OUTPUT

88. <DEC> ::= <PROC DEC>

89.          / <INPUT SPEC>

90.          / <OUTPUT SPEC>

91.          / <DUPLEX SPEC>

92. <DEC GP> ::= <DEC> ;

93.          / <DEC GP> <DEC> ;

94. <DUPLEX SPEC> ::= DUPLEX <TRANSMISSION BODY> END DUPLEX

95. <BINARY SPEC> ::= BINARY : <BINARY BODY> END BINARY

96. <ARITHMETIC SPEC> ::= ARITHMETIC : <ARITHMETIC BODY>
      END ARITHMETIC

97. <TRANSMISSION BODY> ::= <TRANSMISSION DEC> ;

98.          / <TRANSMISSION BODY> <TRANSMISSION DEC> ;

99. <TRANSMISSION DEC> ::= *ID* , <BINARY PRECISION> ,
      <TECHNOLOGY>

100. <BINARY BODY> ::= <BINARY DEC> ;

101.          / <BINARY BODY> <BINARY DEC> ;

102. <BINARY DEC> ::= *ID* <STRUCTURE> , <BINARY PRECISION>
      <INITIAL VALUE>

```



```

103. <ARITHMETIC BODY> ::= <ARITHMETIC DEC> ;
104.           / <ARITHMETIC BODY> <ARITHMETIC DEC> ;
105. <ARITHMETIC DEC> ::= *ID* <STRUCTURE> ,
           <DECIMAL PRECISION> <INITIAL VALUE>
106. <STRUCTURE> ::=
107.           / ( <NUMBER LIST> )
108. <NUMBER LIST> ::= *NUMBER*
109.           / <NUMBER LIST> , *NUMBER*
110. <BINARY PRECISION> ::= *NUMBER*
111. <DECIMAL PRECISION> ::= *NUMBER*
112. <INITIAL VALUE> ::=
113.           / , *NUMBER*
114. <TECHNOLOGY> ::= TTL
115.           / ECL
116.           / ITL
117. <CODE VAR SPEC> ::= CODE VARIABLES : <CODE DEC LIST>
           END CODE VARIABLES
118. <CODE DEC LIST> ::= <CODE DEC> ;
119.           / <CODE DEC LIST> <CODE DEC> ;
120. <CODE DEC> ::= *ID* : <CODE ID>
121. <CODE SPEC> ::= CODE : *ID* , <BINARY PRECISION> ;
           <CHARACTER REP LIST> END CODE
122. <CHARACTER REP LIST> ::= <CHARACTER REP> ;
123.           / <CHARACTER REP LIST> <CHARACTER REP> ;
124. <CHARACTER REP> ::= *ID* : *NUMBER*
125. <CODE ID> ::= *ID*
126.           / ASCII6

```



```

127.          / ASCII7
128.          / EBCDIC
129.          / BCD

130. <ID LIST> ::=
131.          / *ID*
132.          / <ID LIST> , *ID*

133. <NAME> ::= *ID*
134.          / *ID* ( <EXPR LIST> )
135.          / *ID* { *NUMBER* : *NUMBER* }

136. <FORMAL PARAM LIST> ::=
137.          / ( <ID LIST> : <ID LIST> )

138. <PROC> ::= <TASK>
139.          / <FUNCTION>

140. <TASK> ::= <TASK_HEAD> ; <ZOPT PROC DEC GP> <STMT GP>
          END *ID*

141. <ZOPT PROC DEC GP> ::=
142.          / <PROC DEC GP>

143. <PROC DEC GP> ::= <PROC DEC> ;
144.          / <PROC DEC GP> <PROC DEC> ;

145. <TASK_HEAD> ::= TASK *ID* <FORMAL PARAM LIST>
146. <FUNCTION> ::= <FUNCTION_HEAD> ; <ZOPT PROC DEC GP>
          <STMT> END *ID*

147. <FUNCTION_HEAD> ::= FUNCTION *ID* <FORMAL PARAM LIST> :
          BINARY , <BINARY PRECISION> <INITIAL VALUE>
148.          / FUNCTION *ID* <FORMAL PARAM LIST> :
          ARITHMETIC , <DECIMAL PRECISION> <INITIAL VALUE>

149. <PROC GP> ::= <PROC> ;
150.          / <PROC GP> <PROC> ;

151. <PROC SECTION> ::=

```



```

152.          / PROCEDURES <PROC GP>

153. <ROE> ::= <PERIOD>

154. <B1> ::= <PERIOD>

155. <B2> ::= <PERIOD>

156. <RANK> ::= <NU>

157.          / <NU> . <PI>

158. <NU> ::= *NUMBER*

159. <PI> ::= *NUMBER*

160. <QUALIFICATION> ::=

161.          / IF <EXPRESSION>

162. <EPISODE TIMING> ::=

163.          / : <ROE>

164.          / : <ROE> , <B1>

165.          / : <ROE> , <B1> , <B2>

166.          / : <ROE> , <B1> , <B2> , <RANK>

167. <WHEN DO> ::= <QUALIFICATION> WHEN <NAME>
                <EPISODE TIMING> DO <TASK LIST>

168. <SIMPLE DO> ::= <QUALIFICATION> DO <TASK LIST> <RANK>

169. <EVERY> ::= <QUALIFICATION> EVERY <ROE> DO <TASK LIST>

170. <AT TIME> ::= <QUALIFICATION> AT <TIME> DO <TASK LIST>

171. <TASK LIST> ::= <NAME>

172.          / <TASK LIST> THEN <NAME>

173. <CONTINGENCY DEF> ::= <WHEN DO>

174.          / <SIMPLE DO>

175.          / <EVERY>

176.          / <AT TIME>

177. <LIST BODY> ::= <CONTINGENCY DEF> ;

```



```

173.          / <LIST BODY> <CONTINGENCY DEF> ;

179. <CONTINGENCY LIST> ::=

180.          / CONTINGENCY LIST <LIST BODY>

181. <DESIGN CRITERIA> ::=

182.          / DESIGN CRITERIA METRIC <METRIC> ;
          VOLUMES <NUMBER LIST> ; MONITORS <NUMBER LIST> ;

183. <METRIC> ::= FIRST
184.          / COST
185.          / POWER

186. <ENVIRONMENT SECTION> ::=

187.          / ENVIRONMENT <DEC GP>

188. <ID SECTION> ::=

189.          / IDENTIFICATION DESIGNER : *STRING*
          DATE : *STRING* PROJECT : *STRING*

190. <CONTROL SYSTEM DESIGN> ::= <ID SECTION>
          <DESIGN CRITERIA> <ENVIRONMENT SECTION> <PROC SECTION>
          <CONTINGENCY LIST>

```


PRIMITIVE LIST

P	1t.generated	for:	SYSTEM	*****
P	2s.MAIN	()		
P	3d.FIRST	:8,0,0,0,0,0,0,	0:	0:
P	4s.INPUTPORT	(CONSIN,TTL:8)		
P	5s.INPUTPORT	(CONST,TTL:8)		
P	6s.INPUTPORT	(FLGA,TTL:1)		
P	7s.INPUTPORT	(PINA,TTL:8)		
P	8s.INPUTPORT	(FLGB,TTL:1)		
P	9s.INPUTPORT	(PINB,TTL:8)		
P	10s.OUTPUTPORT	(VA,TTL:8)		
P	11s.OUTPUTPORT	(VB,TTL:8)		
P	12s.var	(KCA:8,0)		
P	13s.var	(KCB:8,0)		
P	14s.var	(CNTB:8,0)		
P	15s.var	(ITIA:8,0)		
P	16s.var	(ITIB:8,0)		
P	17s.var	(AINT:8,0)		
P	18s.var	(TDA:8,0)		
P	19s.var	(TDB:8,0)		
P	20s.var	(BINT:8,0)		
P	21s.var	(VSA:8,0)		
P	22s.var	(VSB:8,0)		
P	23s.var	(BDIFF:8,0)		
P	24s.var	(PSA:8,0)		
P	25s.var	(PSB:8,0)		
P	26s.var	(CONPTT:8,0)		
P	27s.var	(EA:8,0)		
P	28s.var	(EB:8,0)		
P	29s.var	(KPIA:8,0)		
P	30s.var	(EA1:8,0)		
P	31s.var	(EA2:8,0)		
P	32s.var	(EB1:8,0)		
P	33s.var	(EB2:8,0)		
P	34s.var	(KPIB:8,0)		
P	35t.generated	for:DATAA		
P	36s.proc	(DATAA:)		
P	37s.sensecond	(FLGA:1)		
P	38s.eq	(@T01,FLGA,@C01:8,1,8)		
P	39s.jmpf	(@T01,@01:8)		
P	40s.assign	(DATAA,@C01:1,8)		
P	41s.loc	(@01:)		
P	42s.exitproc	(DATAA:)		
P	43t.generated	for:DATAB		
P	44s.proc	(DATAB:)		
P	45s.sensecond	(FLGB:1)		
P	46s.eq	(@T01,FLGB,@C01:8,1,8)		
P	47s.jmpf	(@T01,@02:8)		
P	48s.assign	(DATAB,@C01:1,8)		
P	49s.loc	(@02:)		
P	50s.exitproc	(DATAB:)		
P	51t.generated	for:BCNT		
P	52s.proc	(BCNT:)		
P	53s.ge	(@T01,CNTB,@C02:8,8,8)		


```

P 54s.jmpf      (@T01,@03:8)
P 55s.assign   (BCNT,@C01:1,8)
P 56s.loc      (@03:)
P 57s.exitproc (BCNT:)
P 58t.generated for:AFIX
P 59s.proc     (AFIX:)
P 60s.var      (ADIFF:8,0)
P 61s.sensecond (PINA:8)
P 62s.mult     (@T01,PINA,KCA:8,8,8)
P 63s.sub      (@T01,@T01,PSA:8,8,8)
P 64s.assign   (EA,@T01:8,8)
P 65s.mult     (@T01,@C03,EA:8,8,8)
P 66s.mult     (@T02,@C02,EA1:8,8,8)
P 67s.sub      (@T01,@T01,@T02:8,8,8)
P 68s.add      (@T01,@T01,EA2:8,8,8)
P 69s.mult     (@T01,@T01,@C04:8,8,8)
P 70s.assign   (ADIFF,@T01:8,8)
P 71s.divide   (@T01,EA,KCA:8,8,8)
P 72s.add      (@T01,AINT,@T01:8,8,8)
P 73s.assign   (AINT,@T01:8,8)
P 74s.mult     (@T01,ITIA,AINT:8,8,8)
P 75s.add      (@T01,EA,@T01:8,8,8)
P 76s.mult     (@T02,TDA,ADIFF:8,8,8)
P 77s.add      (@T01,@T01,@T02:8,8,8)
P 78s.mult     (@T01,KCA,@T01:8,8,8)
P 79s.add      (@T01,VSA,@T01:8,8,8)
P 80s.assign   (VA,@T01:8,8)
P 81s.issuevent (VA:8)
P 82s.assign   (DATAA,@C05:1,8)
P 83s.assign   (EA2,EA1:8,8)
P 84s.assign   (EA1,EA:8,8)
P 85s.exitproc (AFIX:)
P 86t.generated for:BCALC
P 87s.proc     (BCALC:)
P 88s.sensecond (PINB:8)
P 89s.mult     (@T01,PINB,KCB:8,8,8)
P 90s.sub      (@T01,@T01,PSB:8,8,8)
P 91s.assign   (EB,@T01:8,8)
P 92s.mult     (@T01,@C03,EB:8,8,8)
P 93s.mult     (@T02,@C02,EB1:8,8,8)
P 94s.sub      (@T01,@T01,@T02:8,8,8)
P 95s.add      (@T01,@T01,EB2:8,8,8)
P 96s.mult     (@T01,@T01,@C06:8,8,8)
P 97s.assign   (BDIFF,@T01:8,8)
P 98s.divide   (@T01,EB,KCB:8,8,8)
P 99s.add      (@T01,BINT,@T01:8,8,8)
P 100s.assign  (BINT,@T01:8,8)
P 101s.add     (@T01,CNTB,@C01:8,8,8)
P 102s.assign  (CNTB,@T01:8,8)
P 103s.assign  (DATAB,@C05:1,8)
P 104s.exitproc (BCALC:)
P 105t.generated for:BFIX
P 106s.proc    (BFIX:)

```

```

P 107s.assign (CNTB,@C05:8,8)
P 108s.mult (@T01,ITIB,BINT:8,8,8)
P 109s.add (@T01,EB,@T01:8,8,8)
P 110s.mult (@T02,TDB,BDIFF:8,8,8)
P 111s.add (@T01,@T01,@T02:8,8,8)
P 112s.mult (@T01,KCB,@T01:8,8,8)
P 113s.add (@T01,VSB,@T01:8,8,8)
P 114s.assign (VB,@T01:8,8)
P 115s.issuevent (VB:8)
P 116s.exitproc (BFIX:8)
P 117t.generated for:CONFLG
P 118s.proc (CONFLG:8)
P 119s.sensecond (CONFIN:8)
P 120s.gt (@T01,CONFIN,@C05:8,8,8)
P 121s.jmpf (@T01,@04:8)
P 122s.assign (CONFLG,@C05:1,8)
P 123s.loc (@04:8)
P 124s.exitproc (CONFLG:8)
P 125t.generated for:CHGCON
P 126s.proc (CHGCON:8)
P 127s.sensecond (CONST:8)
P 128s.eq (@T01,CONPTT,@C01:8,8,8)
P 129s.jmpf (@T01,@05:8)
P 130s.assign (KCA,CONST:8,8)
P 131s.loc (@05:8)
P 132s.eq (@T01,CONPTT,@C07:8,8,8)
P 133s.jmpf (@T01,@06:8)
P 134s.divide (@T01,@C01,CONST:8,8,8)
P 135s.assign (ITIA,@T01:8,8)
P 136s.loc (@06:8)
P 137s.eq (@T01,CONPTT,@C03:8,8,8)
P 138s.jmpf (@T01,@07:8)
P 139s.assign (TDA,CONST:8,8)
P 140s.loc (@07:8)
P 141s.eq (@T01,CONPTT,@C02:8,8,8)
P 142s.jmpf (@T01,@08:8)
P 143s.assign (VSA,CONST:8,8)
P 144s.loc (@08:8)
P 145s.eq (@T01,CONPTT,@C04:8,8,8)
P 146s.jmpf (@T01,@09:8)
P 147s.assign (PSA,CONST:8,8)
P 148s.loc (@09:8)
P 149s.eq (@T01,CONPTT,@C08:8,8,8)
P 150s.jmpf (@T01,@10:8)
P 151s.assign (AINT,CONST:8,8)
P 152s.loc (@10:8)
P 153s.eq (@T01,CONPTT,@C09:8,8,8)
P 154s.jmpf (@T01,@11:8)
P 155s.assign (KCB,CONST:8,8)
P 156s.loc (@11:8)
P 157s.eq (@T01,CONPTT,@C10:8,8,8)
P 158s.jmpf (@T01,@12:8)
P 159s.divide (@T01,@C01,CONST:8,8,8)

```

```

P 160s.assign
P 161s.loc
P 162s.eq
P 163s.jmpf
P 164s.assign
P 165s.loc
P 166s.eq
P 167s.jmpf
P 168s.assign
P 169s.loc
P 170s.eq
P 171s.jmpf
P 172s.assign
P 173s.loc
P 174s.eq
P 175s.jmpf
P 176s.assign
P 177s.loc
P 178s.exitproc
A 1 :DATAA :MS: 100, 0, 0, 0, 0
A 2 :DATAB :BCALC :MS: 50, 0, 0, 0, 0
A 3 :BCNT :BFIX :MS: 100, 0, 0, 0, 0
A 4 :CONFLG :CHGCON :MS: 0, 0, 0, 0, 0
P 179t.generated for: SYSTEM *****
P 180s.cons (@C01:1,8)
P 181s.cons (@C02:4,8)
P 182s.cons (@C03:3,8)
P 183s.cons (@C04:5,8)
P 184s.cons (@C05:0,8)
P 185s.cons (@C06:10,8)
P 186s.cons (@C07:2,8)
P 187s.cons (@C08:6,8)
P 188s.cons (@C09:7,8)
P 189s.cons (@C10:8,8)
P 190s.cons (@C11:9,8)
P 191s.cons (@C12:11,8)
P 192s.cons (@C13:12,8)
P 193s.var (@T01:8)
P 194s.var (@T02:8)
(ITIB,@T01:8,8)
(@12:)
(@T01,CONPTT,@C11:8,8,8)
(@T01,@13:8)
(TDB,CONST:8,8)
(@13:)
(@T01,CONPTT,@C06:8,8,8)
(@T01,@14:8)
(VSB,CONST:8,8)
(@14:)
(@T01,CONPTT,@C12:8,8,8)
(@T01,@15:8)
(PSB,CONST:8,8)
(@15:)
(@T01,CONPTT,@C13:8,8,8)
(@T01,@16:8)
(BINT,CONST:8,8)
(@16:)
(CHGCON:)

```


APPENDIX D TRANSLATOR SOURCE LISTING

```

0001 PROGRAM CSDL (DAT,INPUT,OUTPUT,PRIMFILE,TRANSLATE,SYMFILE);
0002 (*This program uses the output from the CSDL syntax-directed*)
0003 (*editor. The output is in standard CSDL form and is *)
0004 (*translated into a primitive list, contained in PRIMFILE, *)
0005 (*and the results of the parse in the OUTPUT file. *)
0006
0007 LABEL 99;
0008
0009 CONST
0010 (* Constants generated by the translator as a result of the *)
0011 (* CSDL syntax being fed through the automatic parser generator. *)
0012
0013 FRESIZE = 397; (*ARRAY LENGTH LIMITS*)
0014 NSETSIZE = 205;
0015 LSETSIZE = 63;
0016
0017 LSSIZE = 573;
0018 PRODSIZE = 205;
0019 FTRNSIZE = 397;
0020 TRANSIZE = 1161;
0021 ENTSIZE = 396;
0022 LHSSIZE = 190;
0023 LENSIZE = 190;
0024 FSTATE = 7;
0025 VOCSIZE = 182;
0026 FIRSTRESWD = 24;
0027 LASTRESWD = 81;
0028 NUMTERMINALS = 83;
0029
0030 MAXENT = 182; (*MAXIMUM VALUES OF ARRAY ELEMENTS*)
0031 MAXFRED = 206;
0032 MAXFTRN = 1162;
0033 MAXTRAN = 396;
0034 MAXNSET = 62;
0035 MAXPROD = 190;
0036 MAXLS = 81;
0037 MAXLSET = 574;
0038 MAXLEN = 11;
0039 MAXLHS = 182;
0040
0041 (*PROGRAM CONSTANTS*)
0042
0043 ENDTOK = 42; IDTOK = 5; NUMTOK = 6;
0044 ARROWTOK = 21; EQUIVALENCE = 20; PWRTOK = 4;
0045 BECOMESTOK = 15; NOTEQTOK = 13; LESSEQTOK = 18;
0046 GTREQTOK = 23; STRINGTOK = 7;
0047
0048 MAXSTK = 40; (* SIZE OF STACK USED IN PARSER *)
0049 TABSIZE = 54; (* SIZE OF SYMBOL TABLE *)
0050 LINELENGTH = 120; (* MAX LENGTH OF INPUT LINES *)
0051 PAGESIZE = 53; (* NUMBER OF LINES PRINTED PER PAGE *)
0052 LINERRARRAYSIZE = 10; (* MAX NO OF ERRORS FLAGGED PER INPUT LINE +2 *)
0053

```



```

0054 MAXSTRINGS = 100; (* MAX LENGTH OF STRINGHEAD ARRAY *)
0055 MAXSTORE = 1000; (* MAX LENGTH OF STRINGSTORE ARRAY *)
0056 TEMPLISTMAX = 25; (* MAX LENGTH OF A UTILITY IN SEMANTIC *)
0057 MAXTEMPS = 20; (* MAX LENGTH OF A UTILITY IN SEMANTIC *)
0058 TPOOLBSIZE = 10; (* CONSTANT USED IN SEMANTIC *)
0059 MAXEVALSTACK = 20; (* DEPTH OF ARTH EVAL STACK *)
0060 MAXOPS = 10; (* MAX NUMBER OF OPS HELD IN STORAGE FOR PRINTING *)
0061 MAXSELS = 10; (* MAX NUMBER OF SELS HELD IN STORAGE FOR PRINTING *)
0062 CSSMAX = 20; (* MAX LENGTH OF A UTILITY IN SEMANTIC *)
0063
0064
0065
0066
0067
0068
0069
0070
0071
0072
0073
0074
0075
0076
0077
0078
0079
0080
0081
0082
0083
0084
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0090
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0106

TYPE

(*SYMBOL TABLE TYPES*)

ALFA = VARYING[MAXSTORE] OF CHAR;
KINDS = (UNDEFINED,RESWD,BINARY,ARITHMETIC,WORD,CHAREP,
TRANSDEC,TASK,FUNCTN);
EXPTYPES = (INT,REEL,BOOL,STNG,ERRORS);
SYMPTR = SYMENTRY;
SYMENTRY = RECORD
    SYMNAME : ALFA;
    LINK : SYMPTR;
CASE KIND : KINDS OF
    (*1*) RESWD : (KEY1 : INTEGER);
    (*2*) BINARY : (PRECISION2, IVAL2 : INTEGER);
    (*3*) ARITHMETIC : (PRECISION3, IVAL3 : INTEGER);
    (*4*) WORD : (CODID4 : SYMPTR; STRINGPTR4 : INTEGER);
    (*5*) CHAREP : (CODID5 : SYMPTR; IVAL5 : INTEGER);
    (*6*) TRANSDEC : (TYPE6, TECHNOLOGY6 : SYMPTR;
        PRECISION6 : INTEGER);
    (*7*) TASK : (PARAMLIST7 : SYMPTR);
    (*8*) FUNCTN : (PARAMLIST8, TYPE8 : SYMPTR;
        PRECISION8, IVAL8 : INTEGER);
END;

(*SEMANTIC TYPES*)

SWITCHES = (TRACEPARSE,TRACETOK,PRINTTABLE);
DESCRIPTOR = RECORD (* DESCRIBES THE CURRENT TOKEN *)
    SYMNAME,IMPNAME : ALFA;
    LINEPOS,
    INTVAL : INTEGER; (* INTEGER VAL OF CURRENT NUMBER *)
    REALVAL : REAL; (* REAL VAL OF CURRENT NUMBER *)
    CHARVAL : CHAR; (* VAL OF CURRENT CHAR LITERAL *)
    SYMLOC : SYMPTR; (* SYMBOL LOC IN SYMBOL TABLE *)
END;

TAGTYPE = (QNUM,QNAME);

VAR
```


0107
0108
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0115
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0123
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0125
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0158
0159

```

PRIMFILE : TEXT;
DAT : TEXT ; TEXT;
TRANSLATE : TEXT;
SYMFIL : TEXT;

FRED : PACKED ARRAY[1..FREDSIZE] OF 1..MAXFRED;
NSET : PACKED ARRAY[1..NSETSIZE] OF 1..MAXNSET;
LSET : PACKED ARRAY[1..LSETSIZE] OF 1..MAXLSET;
LS : PACKED ARRAY[1..LSSIZE] OF 1..MAXLS;
PROD : PACKED ARRAY[1..PRODSIZE] OF 1..MAXPROD;

FTRN : PACKED ARRAY[1..FTRNSIZE] OF 1..MAXFTRN;
TRAN : PACKED ARRAY[1..TRANSIZE] OF 1..MAXTRAN;
ENT : PACKED ARRAY[1..ENTSIZE] OF 1..MAXENT;

LEN : PACKED ARRAY[1..LENSIZE] OF 0..MAXLEN;
LHS : PACKED ARRAY[1..LHSSIZE] OF 1..MAXLHS;

(* PROCEDURE PARSE *)

NEXTSYM, (* NEXT SYMBOL IN INPUT STREAM *)
NOWSTA, (* CURRENT STATE *)
REDUCTION, (* POSSIBLE REDUCTIONS *)
TRANSITION : INTEGER; (* POSSIBLE TRANSITIONS *)

(* STACK VARIABLES *)

STACK : ARRAY[1..MAXSTK] OF RECORD
  STATE : INTEGER; (* STATE STACK *)
  TOK : INTEGER; (* TOKEN STACK *)
  DES : DESCRIPTOR; (* TOKEN DESCRIPTOR *)
  EXPTYPE : EXPTYPES;
END;
STKPTR : INTEGER; (* TOP OF STACK POINTER *)

(* ERROR HANDLING VARIABLES *)

ERRLIST : SET OF 1..58; (* COMPILATION ERROR LIST *)
LINERRORS : ARRAY[1..LINERRARRAYSIZE] OF RECORD
  ERRPOSITION, (* ERROR POSITION *)
  ERRNUM, (* WHICH ERROR *)
  STATE : INTEGER; (* PARSER STATE WHERE ERROR OCCURRED *)
END;
LINERRPTR, (* POINTER INTO LINERRORS *)

```



```

0160 MAXLINEERRORS : INTEGER;
0161 PROGRAMERRFLAG,
0162 OVERFLOWLOGGED : BOOLEAN;
0163
0164 (* PROCEDURE NEXTSYM *)
0165
0166 SPS : ARRAY[CHAR] OF INTEGER;
0167 CC,
0168 LL,
0169 SOURCELINECOUNT,
0170 PAGENUMBER,
0171 PAGELINECOUNT : INTEGER;
0172 CH : CHAR;
0173 LINE : ARRAY[1..LINELENGTH] OF CHAR;
0174 ZDATE, ZTIME : PACKED ARRAY[1..11] OF CHAR;
0175 LASTTOK : BOOLEAN;
0176 BUFFER : ALFA;
0177
0178 (* SYMBOL TABLE VARIABLES *)
0179
0180 SYMTABLE : ARRAY[1..TABSIZ] OF SYMPTR;
0181 AMULT : REAL;
0182 STRINGHEAD : ARRAY[1..MAXSTRINGS] OF INTEGER;
0183 STRINGSTORE : PACKED ARRAY[1..MAXSTORE] OF CHAR;
0184
0185 (* SEMANTIC VARIABLES *)
0186
0187 SWITCH : ARRAY[SWITCHES] OF BOOLEAN;
0188 TEMPLIST : ARRAY[1..TEMPLISTMAX] OF SYMPTR;
0189 TLI : INTEGER;
0190 LINECOUNT,
0191 ALINECOUNT : INTEGER;
0192 FIRSTPARAM : SYMPTR;
0193 LABELCOUNT : INTEGER;
0194
0195 TEMPNAME : ARRAY[1..MAXEVALSTACK] OF RECORD
0196   NAME : ALFA;
0197   PRECISION : INTEGER;
0198   INUSE,USED : BOOLEAN;
0199   END;
0200
0201 EVALSTACK : ARRAY[1..MAXEVALSTACK] OF RECORD
0202   NAME : ALFA;
0203   PRECISION : INTEGER;
0204   END;
0205
0206 ESI : INTEGER;
0207
0208 CONSTANTSTORE : ARRAY[1..CSSMAX] OF RECORD
0209   VAL : INTEGER;
0210
0211
0212

```


333,334,335,16 OF 0);

(* THE EMITS FROM THE CONFIGURATION SETS IN TERMS *)
 (* OF TERMINAL NUMBER *)

ENT := (3,42,50,106,129,37,42,36,112,14,34,43,114,7,58,
 25,30,31,39,54,64,87,96,102,103,109,110,113,133,143,149,66,
 151,35,33,45,65,138,14,14,14,77,5,173,174,14,14,110,16,
 48,70,126,127,150,152,165,166,32,105,14,16,5,85,86,5,93,
 94,5,14,9,42,174,16,173,173,16,5,5,16,152,16,16,56,
 7,78,1,162,42,86,16,162,42,94,16,9,5,99,100,6,95,
 39,16,42,42,1,125,125,148,149,182,16,182,51,89,104,116,136,
 153,158,178,67,6,142,142,9,25,16,9,30,16,95,14,42,100,
 16,9,54,64,5,128,14,149,16,5,46,51,53,55,69,79,81,
 88,92,107,108,123,124,130,131,134,135,140,144,160,161,171,172,175,
 176,177,179,180,181,160,1,5,6,7,8,10,61,84,118,119,120,
 121,122,140,147,155,159,168,16,104,28,38,44,80,14,9,16,2,
 6,111,95,16,5,26,27,29,40,101,31,16,41,52,74,167,9,
 14,25,30,16,1,14,82,5,118,6,145,1,1,6,75,118,145,
 38,72,118,140,15,42,161,16,38,118,38,118,42,118,1,71,168,
 20,21,63,24,4,13,17,18,19,22,23,84,156,3,12,139,16,
 145,170,140,164,145,157,140,7,6,59,9,132,132,5,97,98,77,
 5,128,9,117,118,5,92,6,47,49,57,60,62,68,76,169,
 140,140,14,160,160,15,5,16,160,14,160,14,5,2,117,119,120,
 121,155,147,168,159,122,38,145,6,72,141,154,38,14,115,142,6,
 14,42,98,16,2,111,95,2,9,14,14,118,2,2,145,42,42,
 42,145,42,6,137,164,140,11,164,157,38,16,6,31,16,132,132,
 118,128,6,73,46,51,53,81,6,146,9,164,2,83,118,90,145,
 14,9,137,91,145,9,154);

(* THE POSITION OF EACH REDUCTION FOR EACH CONFIGURATION SET *)

FRED := (1,1,2,2,3,3,4,4,5,5,5,5,6,
 6,6,6,6,6,6,7,8,9,10,11,11,12,13,14,
 15,15,16,16,17,18,19,19,19,19,19,19,19,19,19,19,
 19,20,20,20,21,21,22,22,23,23,23,24,24,24,24,25,25,25,
 26,26,26,26,26,26,27,27,27,28,29,30,31,31,32,
 33,34,34,34,34,34,34,35,35,35,35,36,36,36,36,
 37,37,38,39,39,40,40,41,42,42,42,43,43,44,44,
 45,47,47,48,49,50,50,50,50,51,52,52,53,54,54,54,
 54,54,55,55,56,57,58,58,58,59,61,61,61,61,61,61,
 61,62,63,64,65,66,66,67,67,68,69,69,69,70,70,71,
 71,72,73,73,74,74,74,74,75,76,77,78,79,79,80,
 81,82,83,84,85,86,87,88,89,90,90,90,90,90,90,90,
 90,91,92,93,94,95,96,97,98,99,100,100,101,102,103,104,
 105,105,106,106,107,108,108,108,108,109,109,110,110,110,111,112,
 112,113,113,114,115,116,116,116,117,117,117,117,117,118,
 119,120,120,120,120,120,121,122,123,124,125,126,126,127,128,
 128,129,130,130,131,131,132,132,133,134,135,135,136,137,137,
 137,138,139,139,139,139,140,142,143,144,145,146,147,148,
 149,150,150,150,150,150,151,152,153,153,153,154,155,155,
 156,157,158,159,160,161,162,163,163,164,165,166,167,167,
 167,168,168,168,169,170,171,172,173,173,174,174,175,176,177,

0319
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0321
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0352
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0354
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0360
0361
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0369
0370
0371

177, 177, 177, 178, 178, 179, 180, 181, 182, 182, 183, 184, 184, 185, 186, 187, 188,
189, 190, 191, 191, 191, 191, 192, 193, 194, 195, 196, 197, 197, 198, 199, 200, 200,
201, 202, 202, 202, 203, 204, 205, 205, 206);

(* THE POSITION OF EACH TRANSITION FOR EACH CONFIGURATION SET *)

FTRN := (1,2,5,6,7,9,10,10,11,13,14,
15,31,33,34,38,39,40,42,45,46,47,47,47,
47,47,62,63,63,63,63,71,73,74,74,74,74,
74,75,78,81,82,83,84,87,88,91,94,95,95,
96,97,97,98,105,106,106,107,108,108,109,110,112,
115,116,118,121,122,123,126,128,129,130,130,133,136,
136,138,140,150,151,151,161,169,170,172,174,175,176,
177,177,178,179,180,180,182,183,186,187,187,188,188,
188,189,190,192,193,193,201,202,232,232,262,280,280,
281,281,288,292,292,293,293,295,297,299,299,299,
301,301,301,302,308,309,310,310,314,314,314,316,
318,319,319,322,323,341,343,344,345,365,365,365,
365,365,366,366,367,367,367,385,386,386,416,417,417,
418,418,418,436,436,437,455,485,503,505,505,505,
505,506,514,515,516,517,518,519,519,519,519,529,532,
532,533,536,539,542,544,545,546,547,547,549,551,
554,554,554,554,554,554,554,555,555,555,555,555,
556,558,559,560,560,579,606,607,608,609,616,616,618,
620,627,627,629,629,659,689,690,691,691,692,693,693,
723,725,755,757,758,760,779,779,782,799,815,830,844,
850,850,850,850,850,850,858,871,871,871,878,878,
878,881,881,885,885,886,888,888,888,890,891,891,891,
892,895,896,896,898,900,902,905,906,908,908,909,
927,927,927,927,927,927,927,927,928,929,931,961,991,
991,991,991,1021,1023,1053,1055,1055,1055,1057,1058,1059,1060,
1060,1060,1063,1066,1067,1070,1070,1070,1072,1073,1076,1079,
1080,1082,1082,1083,1084,1085,1085,1085,1087,1089,1089,1107,1109,
1110,1112,1112,1112,1113,1114,1115,1115,1116,1116,1117,
1117,1119,1120,1121,1124,1124,1124,1124,1124,1124,1125,1127,
1128,1146,1146,1146,1146,1146,1146,1149,1150,1150,1152,
1153,1153,1155,1158,1158,1159,1159,1162,1162);

(* TRANSITIONS *)

TRAN := (2,3,4,5,6,7,8,9,10,11,12,13,14,15,
16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,
33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,16,17,
18,19,20,21,22,23,24,25,48,28,29,30,31,49,50,51,52,
53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,
70,43,71,72,73,43,74,45,43,75,45,76,77,78,79,50,51,
52,53,80,56,57,81,82,83,84,85,86,87,62,88,89,90,86,
91,65,92,93,94,95,96,97,98,99,100,101,102,43,103,72,43,
104,72,105,106,105,107,16,17,18,22,23,24,25,108,109,110,111,
16,17,18,22,23,24,25,108,109,112,113,114,115,116,117,118,119,

0372 120, 121, 122, 123, 122, 124, 125, 126, 127, 128, 129, 130, 99, 131, 132, 96, 133,
0373 134, 135, 136, 137, 138, 139, 140, 141, 16, 17, 18, 22, 23, 24, 25, 142, 143,
0374 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160,
0375 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 144, 145, 146, 147,
0376 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 174,
0377 165, 166, 167, 168, 169, 170, 171, 172, 173, 175, 176, 177, 178, 179, 180, 181, 182,
0378 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 113, 114, 194, 116, 118, 119,
0379 120, 195, 196, 197, 198, 199, 200, 201, 202, 200, 203, 204, 99, 205, 206, 207, 208,
0380 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225,
0381 226, 227, 175, 176, 177, 178, 179, 180, 181, 182, 228, 184, 185, 186, 187, 188, 189,
0382 190, 191, 192, 229, 230, 231, 232, 175, 176, 233, 178, 179, 180, 181, 234, 182, 235,
0383 184, 185, 186, 187, 188, 236, 189, 190, 191, 192, 237, 238, 175, 176, 177, 178, 179,
0384 180, 181, 182, 239, 184, 185, 186, 187, 240, 189, 190, 191, 192, 241, 144, 242, 145,
0385 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162,
0386 163, 243, 166, 167, 168, 169, 170, 171, 172, 173, 244, 245, 175, 176, 177, 178, 179,
0387 180, 181, 182, 246, 184, 185, 186, 187, 188, 189, 190, 191, 192, 247, 175, 176, 177,
0388 178, 179, 180, 181, 182, 248, 184, 185, 186, 187, 188, 189, 190, 191, 192, 144, 249,
0389 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161,
0390 162, 163, 243, 166, 167, 168, 169, 170, 171, 172, 173, 175, 176, 177, 178, 179, 180,
0391 181, 182, 250, 184, 185, 186, 187, 188, 189, 190, 191, 192, 251, 226, 252, 175, 176,
0392 177, 178, 187, 188, 189, 253, 254, 255, 256, 257, 258, 179, 180, 259, 260, 261, 262,
0393 263, 264, 265, 266, 267, 268, 269, 270, 229, 271, 272, 176, 273, 274, 229, 275, 276,
0394 176, 277, 278, 279, 280, 281, 282, 281, 283, 284, 285, 286, 287, 288, 139, 289, 290,
0395 291, 175, 176, 177, 178, 179, 180, 181, 182, 292, 293, 184, 185, 186, 187, 188, 189,
0396 190, 191, 192, 294, 145, 146, 147, 148, 149, 150, 151, 152, 295, 154, 155, 156, 157,
0397 158, 159, 161, 162, 163, 166, 167, 168, 169, 170, 171, 172, 173, 296, 297, 254, 298,
0398 299, 300, 301, 302, 303, 304, 176, 305, 176, 306, 298, 299, 300, 301, 302, 303, 304,
0399 307, 254, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158,
0400 159, 160, 161, 162, 163, 308, 165, 166, 167, 168, 169, 170, 171, 172, 173, 144, 145,
0401 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162,
0402 163, 309, 165, 166, 167, 168, 169, 170, 171, 172, 173, 254, 310, 311, 312, 144, 145,
0403 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162,
0404 163, 313, 165, 166, 167, 168, 169, 170, 171, 172, 173, 314, 254, 144, 145, 146, 147,
0405 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 315,
0406 165, 166, 167, 168, 169, 170, 171, 172, 173, 316, 254, 317, 318, 254, 175, 176, 177,
0407 178, 179, 180, 181, 182, 319, 293, 184, 185, 186, 187, 188, 189, 190, 191, 192, 267,
0408 268, 269, 175, 176, 177, 178, 179, 180, 181, 182, 320, 185, 186, 187, 188, 189, 190,
0409 191, 192, 175, 176, 177, 178, 179, 180, 181, 182, 321, 186, 187, 188, 189, 190, 191,
0410 192, 175, 176, 177, 178, 179, 180, 181, 182, 322, 187, 188, 189, 190, 191, 192, 175,
0411 176, 177, 178, 179, 180, 181, 182, 187, 188, 189, 323, 191, 192, 175, 176, 177, 178,
0412 188, 324, 175, 176, 177, 178, 187, 188, 189, 325, 175, 176, 177, 178, 179, 180, 181,
0413 182, 187, 188, 189, 326, 192, 175, 176, 177, 178, 327, 188, 189, 229, 328, 329, 330,
0414 331, 332, 333, 334, 335, 336, 122, 337, 338, 339, 284, 340, 341, 342, 343, 219, 203,
0415 344, 99, 345, 346, 347, 348, 254, 224, 226, 349, 175, 176, 177, 178, 179, 180, 181,
0416 182, 350, 184, 185, 186, 187, 188, 189, 190, 191, 192, 351, 352, 229, 353, 144, 354,
0417 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161,
0418 162, 163, 243, 166, 167, 168, 169, 170, 171, 172, 173, 144, 355, 145, 146, 147, 148,
0419 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 243, 166,
0420 167, 168, 169, 170, 171, 172, 173, 144, 356, 145, 146, 147, 148, 149, 150, 151, 152,
0421 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 243, 166, 167, 168, 169, 170,
0422 171, 172, 173, 229, 357, 144, 358, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154,
0423 155, 156, 157, 158, 159, 160, 161, 162, 163, 243, 166, 167, 168, 169, 170, 171, 172,
0424 173, 359, 360, 346, 347, 255, 256, 257, 267, 268, 269, 179, 180, 265, 258, 176, 273,

361, 176, 362, 363, 176, 273, 364, 229, 275, 365, 366, 200, 367, 368, 369, 370, 281,
 371, 281, 372, 175, 176, 177, 178, 179, 180, 181, 182, 373, 184, 185, 186, 187, 188,
 189, 190, 191, 192, 139, 374, 375, 254, 376, 377, 378, 379, 380, 331, 381, 382, 331,
 383, 176, 273, 384, 254, 385, 219, 386, 175, 176, 177, 178, 179, 180, 181, 182, 387,
 184, 185, 186, 187, 188, 189, 190, 191, 192, 229, 388, 389, 331, 390, 254, 391, 359,
 392, 229, 393, 394, 395, 330, 332, 396);

NSET := (59, 58, 61, 57, 56, 51, 51, 51, 51, 51, 51, 57, 51, 51, 51, 51,
 61, 51, 51, 51, 52, 51, 56, 51, 61, 44, 44, 35, 52, 48, 51, 34, 55,
 34, 53, 35, 35, 43, 51, 35, 42, 51, 34, 55, 51, 51, 53, 61, 51, 51,
 51, 51, 35, 51, 35, 35, 51, 51, 19, 33, 51, 49, 2, 51, 51, 51, 51,
 51, 51, 51, 51, 51, 51, 9, 10, 10, 1, 1, 53, 3, 7, 6,
 4, 10, 10, 5, 5, 8, 54, 44, 43, 51, 51, 51, 51, 51, 51, 51, 51,
 35, 51, 51, 51, 29, 33, 19, 62, 60, 31, 2, 51, 51, 30, 2, 32,
 29, 8, 2, 2, 2, 2, 1, 1, 54, 40, 37, 41, 60, 59,
 28, 51, 51, 19, 19, 49, 51, 51, 36, 36, 36, 36, 36, 36, 2,
 51, 32, 51, 10, 3, 7, 6, 5, 10, 8, 5, 4, 40, 45, 50, 51, 51,
 35, 47, 51, 51, 9, 29, 51, 51, 51, 51, 60, 60, 51, 37, 51, 60, 58,
 51, 51, 35, 51, 51, 19, 51, 51, 51, 51, 51, 50, 50, 51, 51, 9, 60, 41,
 60, 60, 41, 60);

(* REDUCTIONS *)

PROD := (188, 181, 1, 186, 151, 83, 82, 84, 85, 187, 91, 89, 90, 88,
 179, 184, 183, 185, 92, 139, 152, 138, 190, 106, 106, 97, 93, 136, 136, 141, 149,
 141, 160, 103, 100, 110, 94, 98, 130, 145, 142, 150, 176, 175, 160, 180, 174, 173,
 108, 96, 104, 95, 101, 118, 86, 87, 131, 143, 44, 133, 41, 71, 78, 72, 73,
 69, 67, 79, 70, 74, 76, 75, 68, 133, 12, 13, 2, 3, 161, 32, 30, 28,
 18, 14, 16, 26, 24, 20, 177, 107, 111, 112, 125, 126, 127, 129, 128, 120,
 119, 115, 116, 114, 99, 130, 144, 34, 38, 62, 12, 66, 63, 49, 14, 47, 80,
 34, 22, 21, 11, 6, 7, 8, 9, 10, 4, 5, 178, 59, 171, 153, 162, 189,
 109, 105, 102, 117, 132, 35, 133, 44, 77, 52, 53, 55, 57, 54, 56, 58, 48,
 146, 81, 140, 15, 33, 31, 29, 27, 17, 23, 25, 19, 60, 158, 156, 168, 113,
 122, 137, 112, 112, 134, 130, 51, 50, 64, 65, 46, 40, 170, 172, 169, 163, 182,
 124, 121, 123, 148, 147, 36, 42, 37, 61, 39, 159, 157, 167, 45, 135, 164, 154,
 43, 165, 155, 166);

(* LOOK AHEAD SETS *)

LS := (1, 5, 6, 7, 1, 5, 6, 7, 8, 10, 61, 2, 9, 14, 16, 20, 28, 38, 44, 72,
 73, 80, 2, 3, 8, 9, 10, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24, 28, 38, 44,
 63, 72, 73, 80, 2, 9, 14, 16, 20, 21, 24, 28, 38, 44, 63, 72, 73, 80, 2, 9, 14, 16,
 20, 21, 28, 38, 44, 63, 72, 73, 80, 2, 9, 14, 16, 20, 21, 28, 38, 44, 72, 73, 80, 2,
 8, 9, 10, 13, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24, 28, 38, 44, 63, 72, 73, 80, 2,
 3, 4, 6, 8, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 28, 38, 44,
 63, 72, 73, 80, 2, 3, 4, 8, 9, 10, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24,
 28, 38, 44, 63, 72, 73, 80, 2, 9, 14, 16, 20, 28, 38, 44, 72, 80, 2, 3, 8, 9, 10,

151,157,90,91,154,154,141,146,153,153,115,115,115,115,115,115,178,158,
 116,89,164,164,104,104,104,104,136,136,105,105,112,112,138,138,138,
 114,114,129,129,106);

(* PARSE INITIALIZATION *)

FUNCTION HASH (SYM : ALFA) : INTEGER;
 (* USED IN ENTER TO CREATE THE INDEX IN THE SYMBOL *)
 (* TABLE FOR EACH SYMBOL *)

VAR KEY : INTEGER;
 BEGIN
 KEY := 17*ORD(SYM[1]) + 15*ORD(SYM[2]) + 13*ORD(SYM[3]) +
 3*ORD(SYM[5]) + ORD(SYM[7]);
 HASH := ROUND((KEY*AMULT)MOD TABSIZE + 1
 END; (*HASH*)

FUNCTION ENTER (SYM : ALFA) : SYMPTR;
 (* ENTERS VALUES IN THE SYMBOL TABLE AND *)
 (* RETURNS THE POINTER TO THE SYMBOL *)

VAR PTR : SYMPTR;
 HASHINDEX : INTEGER;
 BEGIN
 NEW(PTR);
 PTR.SYMNAM := SYM;
 PTR.KIND := UNDEFINED;
 HASHINDEX := HASH(SYM);
 PTR.LINK := SYMTABLE[HASHINDEX];
 SYMTABLE[HASHINDEX] := PTR;
 ENTER := PTR
 END; (*ENTER*)

FUNCTION LOOKUP (SYM : ALFA) : SYMPTR;
 (* LOOKS UP SYMBOLS IN THE SYMBOL TABLE *)
 (* AND RETURNS THE POINTER TO THE SYMBOL DESIRED *)

VAR PTR, SYMLOC : SYMPTR;
 HASHINDEX : INTEGER;
 BEGIN
 SYMLOC := NIL;
 HASHINDEX := HASH(SYM);
 PTR := SYMTABLE[HASHINDEX];
 WHILE PTR <> NIL DO
 IF SYM = PTR.SYMNAM THEN
 BEGIN
 SYMLOC := PTR;
 PTR := NIL
 END
 END


```

0584 ELSE
0585     PTR := PTR.LINK;
0586     LOOKUP := SYMLOC
0587     END; (*LOOKUP*)
0588
0589
0590
0591
0592
0593 PROCEDURE HEADER;
0594     (* PUTS HEADER IN TRANSLATE FILE *)
0595
0596 BEGIN
0597     PAGENUMBER := PAGENUMBER + 1;
0598     WRITELN (TRANSLATE, 'CSDL TRANSLATOR ', ':50, 'PAGE ', PAGENUMBER : 1);
0599     WRITELN (TRANSLATE, 'NAVAL POSTGRADUATE SCHOOL', ':47);
0600     WRITELN (TRANSLATE, ZDATE : 10, ZTIME : 10);
0601     WRITELN(TRANSLATE);
0602     PAGELINECOUNT := 3
0603     END; (*HEADER*)
0604
0605
0606 FUNCTION CHARVAL (NUMBER : INTEGER) : ALFA;
0607     (* USED TO CREATE LOCATION AND TEMPORARY PRIMITIVE VALUES *)
0608
0609 BEGIN
0610     CASE NUMBER OF
0611         0 : CHARVAL := '00';
0612         1 : CHARVAL := '01';
0613         2 : CHARVAL := '02';
0614         3 : CHARVAL := '03';
0615         4 : CHARVAL := '04';
0616         5 : CHARVAL := '05';
0617         6 : CHARVAL := '06';
0618         7 : CHARVAL := '07';
0619         8 : CHARVAL := '08';
0620         9 : CHARVAL := '09';
0621         10 : CHARVAL := '10';
0622         11 : CHARVAL := '11';
0623         12 : CHARVAL := '12';
0624         13 : CHARVAL := '13';
0625         14 : CHARVAL := '14';
0626         15 : CHARVAL := '15';
0627         16 : CHARVAL := '16';
0628         17 : CHARVAL := '17';
0629         18 : CHARVAL := '18';
0630         19 : CHARVAL := '19';
0631         20 : CHARVAL := '20';
0632     END
0633     END; (*CHARVAL*)
0634
0635 PROCEDURE INITIALIZE;
0636     (* INITIALIZES ALL VARIABLES IN THE PROGRAM AND *)
0637     (* CREATES THE STACKS FOR USE IN THE PARSER *)

```



```

0637 VAR I,J,LEN,IDXCPY : INTEGER;
0638 K : SWITCHES;
0639 PTR : SYMPTR;
0640 BEGIN
0641   REWRITE(PRIMFILE);
0642   OPEN(TRANSLATE,RECORDLENGTH := 600);
0643   REWRITE(TRANSLATE);
0644   OPEN(SYMPFILE,RECORDLENGTH := 200);
0645   REWRITE(SYMPFILE);
0646   RESET(DAT);
0647   CH := ' ';
0648   CC := 0;
0649   LL := 0;
0650   LASTOK := FALSE;
0651   SOURCELINECOUNT := 0;
0652   PAGENUMBER := 0;
0653   DATE(ZDATE);
0654   TIME(ZTIME);
0655   HEADER;
0656
0657   SPS['('] := 1; SPS[')'] := 2; SPS['*'] := 3;
0658   SPS['+'] := 8; SPS['-'] := 9; SPS['~'] := 10;
0659   SPS['.'] := 11; SPS['/'] := 12; SPS[':'] := 14;
0660   SPS[';'] := 16; SPS['<'] := 17; SPS['='] := 19;
0661   SPS['>'] := 22; SPS['{'] := 82; SPS['}'] := 83;
0662
0663   FOR I := 1 TO TABSIZE DO SYMTABLE[I] := NIL;
0664   AMULT := 160795.0/262144.0*TABSIZE;
0665
0666   FOR I := FIRSTRESWD TO LASTRESWD DO
0667     BEGIN
0668       LEN := STRINGHEAD[I + 1] - STRINGHEAD[I];
0669       J := 1;
0670       BUFFER := STRINGSTORE[STRINGHEAD[I]];
0671       WHILE J <= LEN - 1 DO
0672         BEGIN
0673           J := J + 1;
0674           IF J <= 10 THEN
0675             BUFFER := BUFFER + STRINGSTORE[STRINGHEAD[I] + (J - 1)];
0676           END;
0677           WHILE J < 10 DO
0678             BEGIN
0679               J := J + 1;
0680               BUFFER := BUFFER + ' ';
0681             END;
0682             PTR := ENTER (BUFFER);
0683             PTR.KIND := RESWD;
0684             PTR.KEY1 := I
0685             END;
0686             PROGRAMERRFLAG := FALSE;
0687
0688
0689

```



```

0690 ERRLIST := { };
0691 LINERRPTR := 0;
0692 OVERFLOWLOGGED := FALSE;
0693 MAXLINERRORS := LINERRARRAYSIZE - 2;
0694 NOWSTA := 1;
0695 NEXTSYM := ENDTOK;
0696 STKPTR := 1;
0697 STACK[1].STATE := 1;
0698 STACK[1].TOK := 0;
0699 DESCRIPTION.SYMNAM := ' ';
0700 DESCRIPTION.INTVAL := 0;
0701 DESCRIPTION.CHARVAL := '@';
0702 DESCRIPTION.REALVAL := 0.0;
0703 DESCRIPTION.SYMLOC := NIL;
0704 BUFFER := ' ';
0705
0706 FOR K := TRACEPARSE TO PRINTTABLE DO
0707   SWITCH[K] := FALSE;
0708   TLI := 0;
0709   FOR I := 1 TO MAXTEMPS DO
0710     BEGIN
0711       TEMPNAME[I].NAME := '@T';
0712       TEMPNAME[I].NAME := TEMPNAME[I].NAME + CHARVAL(I);
0713       IF I IN [1..TPOOLBSIZE] THEN
0714         TEMPNAME[I].PRECISION := 8
0715       ELSE
0716         TEMPNAME[I].PRECISION := 16;
0717       TEMPNAME[I].INUSE := FALSE;
0718       TEMPNAME[I].USED := FALSE
0719     END;
0720   ESI := 0;
0721   FOR I := 1 TO CSSMAX DO
0722     BEGIN
0723       CONSTANTSTORE[I].NAME := '@C';
0724       CONSTANTSTORE[I].NAME := CONSTANTSTORE[I].NAME +
0725         CHARVAL(I);
0726       CONSTANTSTORE[I].VAL := 0;
0727       CONSTANTSTORE[I].PRECISION := 8; (* ADDED COMMENT *)
0728     END;
0729   CSI := 0;
0730   NLI := 0
0731   END; (*INITIALIZE*)
0732
0733   (* PARSING ROUTINES *)
0734
0735   PROCEDURE PUTT (TITLE : ALFA);
0736   (*PLACES TITLE IN PRIMITIVE FILE. *)
0737   BEGIN
0738     LINECOUNT := LINECOUNT + 1;
0739     WRITELN(PRIMFILE, 'P', LINECOUNT : 4, 't.generated for:', TITLE : 10,
0740       ', ', : 10, '*****');
0741     END; (*PUTT*)
0742

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PROCEDURE PUTS (PRIMNAME : ALFA; OPI, SELI : INTEGER);
(*LOADS PRIMITIVE FILE*)

VAR I, J : INTEGER;
BEGIN
  LINECOUNT := LINECOUNT + 1;
  WRITE (PRIMFILE, 'P', LINECOUNT : 4, 'S.', PRIMNAME : 10, '('');
  IF OPI > 0 THEN
    BEGIN
      FOR I := 1 TO OPI - 1 DO
        BEGIN
          FOR J := 1 TO 10 DO
            IF OPSTORE[I][J] <> ' ' THEN
              WRITE (PRIMFILE, OPSTORE[I][J] : 1);
              WRITE (PRIMFILE, ',');
            END;
          FOR J := 1 TO 10 DO
            IF OPSTORE[OPI][J] <> ' ' THEN
              WRITE (PRIMFILE, OPSTORE[OPI][J] : 1);
              WRITE (PRIMFILE, ',');
            END;
          IF SELI > 0 THEN
            BEGIN
              FOR I := 1 TO SELI - 1 DO
                WRITE (PRIMFILE, SELSTORE[I] : 1, ',');
                WRITE (PRIMFILE, SELSTORE[SELI] : 1, ',');
              END
            ELSE
              WRITE (PRIMFILE, ',');
              WRITELN (PRIMFILE)
            END;
          (* PUTS *)
        END;
      END;
    END;
  END;

PROCEDURE PUTSYM (PRIMNAME : ALFA; OPI, SELI : INTEGER);
(* LOADS THE SYMBOL TABLE *)

VAR I, J : INTEGER;
BEGIN
  WRITE(SYMFIL, 'S.', PRIMNAME : 10, '('');
  IF OPI > 0 THEN
    BEGIN
      FOR I := 1 TO OPI - 1 DO
        BEGIN
          FOR J := 1 TO 10 DO
            IF OPSTORE[I][J] <> ' ' THEN
              WRITE(SYMFIL, OPSTORE[I][J] : 1);
              WRITE(SYMFIL, ',');
            END;
          FOR J := 1 TO 10 DO
            IF OPSTORE[OPI][J] <> ' ' THEN
              WRITE(SYMFIL, OPSTORE[OPI][J] : 1);
            END;
          END;
        END;
      END;
    END;
  END;

```



```

0796 WRITE(SYMFIL, ':');
0797 END;
0798 IF SELI > 0 THEN
0799 BEGIN
0800 FOR I := 1 TO SELI - 1 DO
0801 WRITE(SYMFIL, SELSTORE[I] : 1, ',');
0802 WRITE(SYMFIL, SELSTORE[SELI] : 1, ',');
0803 END
0804 ELSE
0805 WRITE(SYMFIL, '');
0806 WRITELN(SYMFIL)
0807 END; (* PUTSYM *)
0808
0809 PROCEDURE GETSYM (VAR NEXTSYM : INTEGER; VAR DES : DESCRIPTOR); FORWARD;
0810 PROCEDURE ERROR (ERRORNUM, INTENSITY, PTOFFSET : INTEGER); FORWARD;
0811
0812 PROCEDURE PUTA (CONTNAME, TASKNAME : ALFA; SELI : INTEGER);
0813 (* UNITS (MS), RHO, BETA1, BETA2, ORDER, PI, GAMMA1, GAMMA2, BCKGRD *)
0814 (* LOADS THE TIMING CONSTRAINTS *)
0815
0816 VAR I : INTEGER;
0817 BEGIN
0818 ALINECOUNT := ALINECOUNT + 1;
0819 WRITE(PRIMFIL, 'A', ALINECOUNT : 4, ', ', CONTNAME : 10, ', ');
0820 TASKNAME : 10, ', MS:');
0821 FOR I := 1 TO SELI - 1 DO
0822 WRITE(PRIMFIL, SELSTORE[I] : 4, ', ');
0823 WRITELN(PRIMFIL, SELSTORE[SELI] : 4)
0824 END; (* PUTA *)
0825
0826 PROCEDURE PUTD (METRIC : ALFA; NUMVOLUMES, NUMMONITORS : INTEGER);
0827 (* LOADS THE DESIGN CRITERIA *)
0828
0829 VAR I : INTEGER;
0830 BEGIN
0831 LINECOUNT := LINECOUNT + 1;
0832 WRITE(PRIMFIL, 'P', LINECOUNT : 4, 'd:', METRIC : 10, ', ');
0833 FOR I := 1 TO NUMVOLUMES - 1 DO
0834 WRITE(PRIMFIL, SELSTORE[I] : 1, ', ');
0835 WRITE(PRIMFIL, SELSTORE[NUMVOLUMES], ', ');
0836 FOR I := NUMVOLUMES + 1 TO NUMVOLUMES + NUMMONITORS DO
0837 WRITE(PRIMFIL, SELSTORE[I], ', ');
0838 WRITELN(PRIMFIL, SELSTORE[NUMVOLUMES + 1 + NUMMONITORS], ', ')
0839 END; (* PUTD *)
0840
0841 FUNCTION CHECKTYPE (EXP1TYPE, EXP2TYPE : EXPTYPES) : EXPTYPES;
0842 (* CHECKS THE TYPES OF INPUT VALUES *)
0843
0844 BEGIN
0845 IF EXP1TYPE = EXP2TYPE THEN
0846 CHECKTYPE := EXP1TYPE
0847 ELSE
0848 CHECKTYPE := ERRORS

```



```

0849 END; (* CHECKTYPE *)
0850
0851 FUNCTION COMPUTPRE (PRE1, PRE2 : INTEGER) : INTEGER;
0852 (* COMPUTS THE PRECISION REQUIRED FOR THE *)
0853 (* RESULT OF AN ARITHMETIC OPERATION *)
0854
0855 BEGIN
0856 IF PRE1 > PRE2 THEN
0857   COMPUTPRE := PRE1
0858 ELSE
0859   COMPUTPRE := PRE2
0860 END; (* COMPUTPRE *)
0861
0862 PROCEDURE NEWTEMP (VAR ZPRECISION : INTEGER; VAR TEMP : ALFA);
0863 (* CHECKS TO SEE IF A VARIABLE NAME HAS BEEN PREVIOUSLY *)
0864 (* DEFINED. IF IT HAS, NEWTEMP RETURNS TRUE. IF NOT, IT *)
0865 (* RETURNS FALSE. *)
0866
0867 CONST LAST8 = 10;
0868 VAR I, STOPSEARCH : INTEGER;
0869 BEGIN
0870   CASE ZPRECISION OF
0871     1,2,3,4,5,6,7,8 :
0872     BEGIN
0873       I := 1;
0874       STOPSEARCH := LAST8
0875     END;
0876     9,10,11,12,13,14,15,16 :
0877     BEGIN
0878       I := LAST8 + 1;
0879       STOPSEARCH := MAXTEMPS
0880     END;
0881     OTHERWISE ERROR(35,1,-1);
0882   END;
0883   WHILE (I <= STOPSEARCH) AND (TEMPNAME[I].INUSE) DO
0884     I := I + 1;
0885   IF I > STOPSEARCH THEN
0886     ERROR(22,1,-1)
0887   ELSE
0888     BEGIN
0889       TEMP := TEMPNAME[I].NAME;
0890       ZPRECISION := TEMPNAME[I].PRECISION;
0891       TEMPNAME[I].INUSE := TRUE;
0892       IF NOT TEMPNAME[I].USED THEN
0893         TEMPNAME[I].USED := TRUE
0894       END
0895     END; (* NEWTEMP *)
0896
0897 PROCEDURE RETURNTEMP (TEMP : ALFA);
0898 (* RETURNS FALSE IF A TEMP IS NEW *)
0899
0899 VAR I : INTEGER;
0900 BEGIN
0901

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0902 I := 1;
0903 WHILE (TEMPNAME[I].NAME <> TEMP) AND (I <= MAXTEMPS) DO
0904   I := I + 1;
0905 IF I > MAXTEMPS THEN
0906   WRITELN(TRANSLATE, ' FIX THE ERROR IN RETURNTEMP')
0907 ELSE
0908   TEMPNAME[I].INUSE := FALSE
0909 END; (* RETURNTEMP *)
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PROCEDURE PRINTTEMPS;
(* LOADS THE VARIABLES *)

VAR I : INTEGER;
BEGIN
  FOR I := 1 TO MAXTEMPS DO
    IF TEMPNAME[I].USED THEN
      BEGIN
        OPSTORE[I] := TEMPNAME[I].NAME;
        SELSTORE[I] := TEMPNAME[I].PRECISION;
        PUTS('var ', 1,1)
      END
    END; (* PRINTTEMPS *)
  END;

PROCEDURE PUSHEVALSTACK (ZNAME : ALFA; ZPRECISION : INTEGER);
(* PUSHES A VARIABLE ON TO THE STACK *)

BEGIN
  ESI := ESI + 1;
  EVALSTACK[ESI].NAME := ZNAME;
  EVALSTACK[ESI].PRECISION := ZPRECISION
END; (*PUSHEVALSTACK *)

PROCEDURE POPEVALSTACK (VAR NAME : ALFA; VAR ZPRECISION : INTEGER);
(* POPS A VARIABLE FROM THE STACK *)

BEGIN
  NAME := EVALSTACK[ESI].NAME;
  ZPRECISION := EVALSTACK[ESI].PRECISION;
  IF (NAME[1] = '@') AND (NAME[2] = 'T') THEN
    RETURNTEMP(NAME);
  ESI := ESI - 1
END; (* POPEVALSTACK *)

PROCEDURE NEWCONS (ZVALUE : INTEGER; VAR ZNAME : ALFA;
  VAR ZPRECISION : INTEGER);
(* CREATES A NEW CONSTANT IF NEEDED. OTHERWISE *)
(* RETURNS THE POINTER TO THE ONE DESIRED *)

VAR I : INTEGER;
BEGIN

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0955 I := 1;
0956 WHILE (I <= CSI) AND (CONSTANTSTORE[I].VAL <> ZVALUE) DO
0957   I := I + 1;
0958   IF I > CSI THEN
0959     BEGIN
0960       CSI := CSI + 1;
0961       CONSTANTSTORE[CSI].VAL := ZVALUE;
0962       IF (ZVALUE >= -127) AND (ZVALUE <= 128) THEN
0963         ZPRECISION := 8
0964       ELSE
0965         IF (ZVALUE >= -32768) AND (ZVALUE <= 32768) THEN
0966           ZPRECISION := 16
0967         ELSE
0968           BEGIN
0969             ERROR(31,1,-1);
0970             ZPRECISION := 16
0971           END;
0972       CONSTANTSTORE[CSI].PRECISION := ZPRECISION;
0973       ZNAME := CONSTANTSTORE[I].NAME
0974     END
0975   ELSE
0976     BEGIN
0977       ZNAME := CONSTANTSTORE[I].NAME;
0978       ZVALUE := CONSTANTSTORE[I].VAL;
0979       ZPRECISION := CONSTANTSTORE[I].PRECISION
0980     END
0981   END; (* NEWCONS *)
0982
0983 PROCEDURE NEWLABEL (VAR LABELNAME : ALFA);
0984
0985   VAR PLACE, LCCOPY : INTEGER;
0986   BEGIN
0987     LABELNAME := '@';
0988     LABELCOUNT := LABELCOUNT + 1;
0989     LCCOPY := LABELCOUNT;
0990     IF LCCOPY > 0 THEN
0991       LABELNAME := LABELNAME + CHARVAL(LCCOPY);
0992     END; (* NEWLABEL *)
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1007
FUNCTION FINDTRANSITION (CSTATE,CTOKEN : INTEGER) : INTEGER;
(* CHECKS TO SEE IF ANY TRANSITIONS EXIST *)

VAR I : INTEGER;
BEGIN
  FINDTRANSITION := 0;
  FOR I := FTRN[CSTATE] TO FTRN[CSTATE + 1] - 1 DO
    IF CTOKEN = ENT[TRAN[I]] THEN
      FINDTRANSITION := TRAN[I]
    END; (* FINDTRANSITION *)
  END;

```



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1008 FUNCTION FINDREDUCTION (CSTATE,CTOKEN : INTEGER) : INTEGER;
1009 (* CHECKS TO SEE IF ANY REDUCTIONS EXIST *)
1010
1011 VAR I, J : INTEGER;
1012 BEGIN
1013   FINDREDUCTION := 0;
1014   FOR I := FRED[CSTATE] TO FRED[CSTATE + 1] - 1 DO
1015     FOR J := LSET[NSET[I]] TO LSET[NSET[I] + 1] - 1 DO
1016       IF CTOKEN = LS[J] THEN
1017         FINDREDUCTION := PROD[I]
1018       END; (*FINDREDUCTION*)
1019     END;
1020   END;
1021
1022 PROCEDURE DOTTRANSITION (NEWSTA : INTEGER);
1023 (* GIVEN THE TRANSITION NUMBER, THIS MODULE *)
1024 (* EXECUTES THE TRANSITION AND RETURNS TO *)
1025 (* PARSE TO CONTINUE THE LOOP *)
1026
1027 BEGIN
1028   IF SWITCH[TRACEPARSE] THEN
1029     WRITELN(TRANSLATE, ' TRANSITION FROM STATE ', NOWSTA :2,
1030             ' TO STATE ', NEWSTA :2);
1031     STKPTR := STKPTR + 1;
1032     IF STKPTR <= MAXSTK THEN
1033       BEGIN
1034         STACK[STKPTR].TOK := NEXTSYM;
1035         STACK[STKPTR].DES := DESCRIPTION;
1036         STACK[STKPTR].STATE := NEWSTA;
1037         NOWSTA := NEWSTA;
1038         GETSYM(NEXTSYM,DESCRIPTION);
1039         IF SWITCH[TRACETOK] THEN
1040           WRITELN(TRANSLATE, ' NEXTSYM = ', NEXTSYM : 2);
1041         END
1042       ELSE
1043         BEGIN
1044           WRITELN(TRANSLATE, 'GOING INTO ERROR IN DOTRAN');
1045           ERROR(8,5,0)
1046         END
1047       END; (*DOTTRANSITION*)
1048
1049     PROCEDURE SEMANTIC (PRODUCTION : INTEGER); FORWARD;
1050     PROCEDURE SEMANTIC1(PRODUCTION : INTEGER); FORWARD;
1051
1052     PROCEDURE DOREDUCTION (PROD : INTEGER);
1053     (* GIVEN THE REDUCTION, THIS MODULE DOES THE REDUCTION *)
1054     (* BY CALLING SEMANTIC WITH THE PARTICULAR CONSTRUCT *)
1055     (* IT HAS RECOGNIZED. DOREDUCTION THEN REMOVES THE *)
1056     (* APPROPRIATE NUMBER OF ITEMS FROM THE STACK AND *)
1057     (* PLACES THE REDUCED VERSION ON THE STACK. *)
1058     BEGIN
1059       SEMANTIC(PROD);
1060

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1061 STKPTR := STKPTR - LEN[PROD];
1062 IF STKPTR <= MAXSTK THEN
1063   BEGIN
1064     NOWSTA := FINDTRANSITION(STACK[STKPTR].STATE, LHS[PROD]);
1065     IF SWITCH[TRACEPARSE] THEN
1066       WRITELN(TRANSLATE, ' PRODUCTION ', PROD : 2,
1067         ' AND TRANSITION FROM STATE ', STACK[STKPTR].STATE : 2,
1068         ' TO STATE ', NOWSTA : 2);
1069     STKPTR := STKPTR + 1;
1070     STACK[STKPTR].TOK := LHS[PROD];
1071     STACK[STKPTR].STATE := NOWSTA
1072   END
1073   ELSE
1074     BEGIN
1075       WRITELN(TRANSLATE, 'GOING INTO ERROR IN DOREDUCTION');
1076       ERROR(9,5,0)
1077     END
1078   END; (* DOREDUCTION *)
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PROCEDURE PARSE;
(* REPEATEDLY EXECUTES UNTIL IT TRANSITIONS TO A FINAL
(* STATE. CALLS FINDREDUCTION TO SEE IF ANY REDUCTIONS
(* EXIST. IF ONE DOES, IT DOES IT BY CALLING DOREDUCTION
(* AND GOES BACK TO REPEAT THE LOOP. IF NO REDUCTIONS
(* EXIST, IT CALLS FINDTRANSITION TO SEE IF ANY TRANSITIONS
(* EXIST. IF ONE DOES, IT CALLS DOTRANSITION AND THEN
(* REPEATS THIS LOOP. IF NEITHER EXIST, THEN EITHER AN
(* ERROR EXISTS OR WE HAVE TRANSITIONED TO A FINAL STATE
*)

BEGIN
REPEAT
  REDUCTION := FINDREDUCTION(NOWSTA,NEXTSYM);
  IF REDUCTION > 0 THEN
    DOREDUCTION(REDUCTION)
  ELSE
    BEGIN
      TRANSITION := FINDTRANSITION(NOWSTA,NEXTSYM);
      IF TRANSITION <> FSTATE THEN
        BEGIN
          IF TRANSITION > 0 THEN
            DOTRANSITION(TRANSITION)
          ELSE
            BEGIN
              WRITELN(TRANSLATE, 'GOING INTO ERROR IN PARSE');
              ERROR(5,4,-1)
            END
          END
        ELSE
          NOWSTA := TRANSITION
        END
      UNTIL NOWSTA =FSTATE

```



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1114 END; (* PARSE *)
1115
1116 (* ERROR HANDLING ROUTINES *)
1117
1118 PROCEDURE PRINTERRORS;
1119
1120 VAR I : INTEGER;
1121 BEGIN
1122   IF PAGELINECOUNT + 10 > PAGESIZE THEN
1123     WRITELN(TRANSLATE,'1');
1124     I := 1;
1125     WRITELN(TRANSLATE);
1126     WRITELN(TRANSLATE, ' ', :25, 'PROGRAM ERRORS');
1127     WRITELN(TRANSLATE, ' ', :25, '*****');
1128     WRITELN(TRANSLATE);
1129     WHILE ERRLIST <> [ ] DO
1130       BEGIN
1131         WHILE NOT (I IN ERRLIST) DO
1132           I := I + 1;
1133         WRITE(TRANSLATE,I : 5);
1134         CASE I OF
1135           1 : WRITELN(TRANSLATE, ' : DIGIT EXPECTED');
1136           2 : WRITELN(TRANSLATE, ' : ERROR IN IDENTIFIER');
1137           3 : WRITELN(TRANSLATE, ' : ERROR IN NUMBER');
1138           4 : WRITELN(TRANSLATE, ' : ERROR IN EXPONENT');
1139           5 : WRITELN(TRANSLATE, ' : IMPROPER CONSTRUCTION, EXPECTED',
1140             ' SYMBOL LIST FOLLOWS');
1141           6 : WRITELN(TRANSLATE, ' : BASED INTEGERS ARE DEFINED ONLY FOR',
1142             ' BASES 2 THROUGH 16');
1143           7 : WRITELN(TRANSLATE, ' : CHARACTER NOT DEFINED FOR THIS BASE');
1144           8 : WRITELN(TRANSLATE, ' : STACK OVERFLOW IN DOTTRANSITION');
1145           9 : WRITELN(TRANSLATE, ' : TO CORRECT, INCREASE CONSTANT MAXSTK');
1146           10 : WRITELN(TRANSLATE, ' : TO CORRECT, INCREASE CONSTANT MAXSTK');
1147           11 : WRITELN(TRANSLATE, ' : END OF FILE ENCOUNTERED');
1148           12 : WRITELN(TRANSLATE, ' : UNKNOWN OR MISPLACED CHARACTER');
1149           13 : WRITELN(TRANSLATE, ' : TOO MANY ERRORS ON THIS LINE');
1150           14 : WRITELN(TRANSLATE, ' : INTEGER VALUE EXPECTED');
1151           15 : WRITELN(TRANSLATE, ' : IDENTIFIER ALREADY DECLARED');
1152           16 : WRITELN(TRANSLATE, ' : CHARACTER ALREADY SPECIFIED');
1153           17 : WRITELN(TRANSLATE, ' : CHARACTER REPRESENTATION MUST BE AN',
1154             ' INTEGER VALUE');
1155           18 : WRITELN(TRANSLATE, ' : UNKNOWN OR MISSING COMPILER OPTION',
1156             ' INSTRUCTION');
1157           19 : WRITELN(TRANSLATE, ' : REALS NOT IMPLEMENTED');
1158           20 : WRITELN(TRANSLATE, ' : OPERATION NOT DEFINED FOR STRING',
1159             ' OPERANDS');
1160         END CASE;
1161       END;
1162     END;
1163   END;
1164 END;
1165

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1166 20: WRITELN(TRANSLATE, ' : TYPE MISMATCH');
1167 21: WRITELN(TRANSLATE, ' : OPERATION NOT DEFINED FOR BOOLEAN',
1168      , OPERANDS');
1169 22: WRITELN(TRANSLATE, ' : TOO MANY REQUESTS FOR TEMP NAMES--',
1170      , INCREASE CONSTANT MAXTEMPS');
1171 23: WRITELN(TRANSLATE, ' : OPERATION NOT DEFINED FOR NUMERICAL',
1172      , OPERANDS');
1173 24: WRITELN(TRANSLATE, ' : PROCEDURE NAME EXPECTED');
1174 25: WRITELN(TRANSLATE, ' : MISMATCHING BEGIN-END PAIR');
1175 26: WRITELN(TRANSLATE, ' : EXPRESSION TYPE MUST BE BOOLEAN');
1176 27: WRITELN(TRANSLATE, ' : ERROR IN FACTOR');
1177 28: WRITELN(TRANSLATE, ' : IDENTIFIER NOT DECLARED');
1178 29: WRITELN(TRANSLATE, ' : INDEX MUST BE DECLARED AS ARITHMETIC');
1179 30: WRITELN(TRANSLATE, ' : THE FOLLOWING ARGUMENT MUST',
1180      , 'BE BINARY');
1181 31: WRITELN(TRANSLATE, ' : CONSTANT TOO LARGE--NOT IN',
1182      , '-32768..32768');
1183 32: WRITELN(TRANSLATE, ' : IMPROPER ASSIGNMENT');
1184 33: WRITELN(TRANSLATE, ' : PARAMETERS NOT IMPLEMENTED');
1185 34: WRITELN(TRANSLATE, ' : TASK NAME EXPECTED');
1186 35: WRITELN(TRANSLATE, ' : REQUEST FOR A TEMPORARY WITH A',
1187      , 'PRECISION > 16');
1188 36: WRITELN(TRANSLATE, ' : STRUCTURED VARIABLES ARE',
1189      , 'NOT IMPLEMENTED');
1190 37: WRITELN(TRANSLATE, ' : BIT FIELDS ARE NOT IMPLEMENTED');
1191 38: WRITELN(TRANSLATE, ' : EXPRESSION TYPES MUST BE INTEGER');
1192 END;
1193 ERRLIST := ERRLIST - [1]
1194 END
1195 END; (*PRINTERRORS*)
1196
1197
1198 PROCEDURE RECOVER;
1199 (* THIS ATTEMPTS TO RECOVER THE PARSE FROM AN *)
1200 (* ERROR SUCH AS AN UNDEFINED VARIABLE *)
1201
1202 CONST NUMSOLIDS = 21;
1203 VAR SOLID : ARRAY[1..NUMSOLIDS] OF INTEGER;
1204
1205 FUNCTION SOLIDTOKEN (TOKEN : INTEGER) : BOOLEAN;
1206 VAR LOWERBOUND, UPPERBOUND, INDEX : INTEGER;
1207 FOUND : BOOLEAN;
1208 BEGIN
1209     LOWERBOUND := 1;
1210     UPPERBOUND := NUMSOLIDS;
1211     FOUND := FALSE;
1212     WHILE (LOWERBOUND < UPPERBOUND) AND (NOT FOUND) DO
1213         BEGIN
1214             INDEX := (LOWERBOUND + UPPERBOUND) DIV 2;
1215             IF TOKEN < SOLID[INDEX] THEN
1216                 UPPERBOUND := INDEX - 1
1217             ELSE
1218                 IF TOKEN > SOLID[INDEX] THEN

```



```

1219 LOWERBOUND := INDEX + 1
1220 ELSE
1221     FOUND := TRUE
1222     END; (*WHILE*)
1223     SOLIDTOKEN := FOUND
1224     END; (* SOLIDTOKEN *)
1225
1226 BEGIN
1227     SOLID[ 1] := 85; SOLID[ 2] := 92; SOLID[ 3] := 97;
1228     SOLID[ 4] := 99; SOLID[ 5] := 105; SOLID[ 6] := 109;
1229     SOLID[ 7] := 112; SOLID[ 8] := 114; SOLID[ 9] := 117;
1230     SOLID[10] := 128; SOLID[11] := 129; SOLID[12] := 135;
1231     SOLID[13] := 136; SOLID[14] := 142; SOLID[15] := 148;
1232     SOLID[16] := 150; SOLID[17] := 151; SOLID[18] := 160;
1233     SOLID[19] := 164; SOLID[20] := 170; SOLID[21] := 173;
1234
1235     WHILE (NOT SOLIDTOKEN(STACK[STKPTR].TOK)) AND
1236           (STKPTR > 2) DO
1237         STKPTR := STKPTR - 1;
1238         WHILE (FINDTRANSITION(STACK[STKPTR].STATE,NEXTSYM) = 0) AND
1239               (FINDREDUCTION(STACK[STKPTR].STATE,NEXTSYM) = 0) AND
1240               (NOT LASTTOK) DO
1241             GETSYM(NEXTSYM,DESCRIPTION);
1242             IF LASTTOK THEN
1243               ERROR(10,5,-1);
1244             NOWSTA := STACK[STKPTR].STATE
1245             END; (*RECOVER *)
1246
1247
1248
1249
1250
1251
1252
1253
1254
1255
1256
1257
1258
1259
1260
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1268
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1271

```

PROCEDURE ERROR (*ERRORNUM, INTENSITY, PTOFFSET : INTEGER *);

```

VAR POSITION : INTEGER;
BEGIN
    WRITELN(TRANSLATE,'IN ERROR SLC = ',SOURCELINECOUNT : 3);
    IF NOT PROGRAMERRFLAG THEN
        PROGRAMERRFLAG := TRUE;
    IF LINERRPTR < MAXLINERRORS THEN
        BEGIN
            LINERRPTR := LINERRPTR + 1;
            LINERRORS[LINERRPTR].ERRPOSITION := CC + PTOFFSET;
            LINERRORS[LINERRPTR].ERRNUM := ERRORNUM;
            LINERRORS[LINERRPTR].STATE := NOWSTA;
            ERRLIST := ERRLIST + [ERRORNUM];
        END
    ELSE
        IF NOT OVERFLOWLOGGED THEN
            BEGIN
                OVERFLOWLOGGED := TRUE;
                LINERRPTR := LINERRPTR + 1;
                LINERRORS[LINERRPTR].ERRPOSITION := CC + PTOFFSET;
                LINERRORS[LINERRPTR].ERRNUM := 12;
                ERRLIST := ERRLIST + [12]
            END;

```



```

1272 IF INTENSITY = 5 THEN
1273   GOTO 99;
1274 IF INTENSITY = 4 THEN
1275   RECOVER
1276 END; (* ERROR *)
1277
1278
1279
1280
1281
1282
1283
1284
1285
1286
1287
1288
1289
1290
1291
1292
1293
1294
1295
1296
1297
1298
1299
1300
1301
1302
1303
1304
1305
1306
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1312
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1314
1315
1316
1317
1318
1319
1320
1321
1322
1323
1324

PROCEDURE PRINTLINERRORS;

VAR LINEPOSITION, MARKER : INTEGER;
    MORERRORS : BOOLEAN;

PROCEDURE PRINTEROR (X : INTEGER);
VAR I, J, K, SYM : INTEGER;
BEGIN
  WITH LINERRORS[X] DO
    BEGIN
      IF ERRPOSITION = LINEPOSITION + 1 THEN
        BEGIN
          WRITE(TRANSLATE, ' ', (ERRPOSITION - LINEPOSITION) - 1, ' ',
                ERRNUM : 2);
          LINEPOSITION := LINEPOSITION + 3
        END
      ELSE
        BEGIN
          WRITE(TRANSLATE, ' ', (ERRPOSITION - LINEPOSITION) - 1, ' ',
                ERRNUM : 2);
          LINEPOSITION := ERRPOSITION + 2;
        END;
      IF ERRNUM = 5 THEN
        BEGIN
          WRITE(TRANSLATE, ' ');
          LINEPOSITION := LINEPOSITION + 1;
          FOR I := FTRN[STATE] TO FTRN[STATE + 1] DO
            BEGIN
              SYM := ENT[TRAN[I]];
              IF SYM <= NUMTERMINALS THEN
                BEGIN
                  FOR J := STRINGHEAD[SYM] TO STRINGHEAD[SYM + 1] - 1 DO
                    BEGIN
                      WRITE(TRANSLATE, STRINGSTORE[J] : 1);
                      LINEPOSITION := LINEPOSITION + 1
                    END;
                  WRITE(TRANSLATE, ' ');
                  LINEPOSITION := LINEPOSITION + 1
                END
              END;
            FOR I := FRED[STATE] TO FRED[STATE + 1] DO
              FOR J := LSET[NSET[I]] TO LSET[NSET[I] + 1] - 1 DO
                BEGIN
                  SYM := LS[J];
                  FOR K := STRINGHEAD[SYM] TO STRINGHEAD[SYM + 1] DO
                    BEGIN
                      WRITE(TRANSLATE, STRINGSTORE[K] : 1);

```



```

1325 LINEPOSITION := LINEPOSITION + 1
1326 END;
1327 WRITE(TRANSLATE, ' ');
1328 LINEPOSITION := LINEPOSITION + 1
1329 END
1330 END
1331 END
1332 END;
1333
1334 BEGIN
1335 MOREERRORS := TRUE;
1336 LINEPOSITION := 0;
1337 MARKER := 1;
1338 WRITE(TRANSLATE, ' **** ');
1339 WHILE MOREERRORS DO
1340 BEGIN
1341 WHILE MARKER <= LINERRPTR DO
1342 BEGIN
1343 IF LINERRORS[MARKER].ERRPOSITION > LINEPOSITION THEN
1344 BEGIN
1345 PRINTERROR(MARKER);
1346 LINERRORS[MARKER].ERRPOSITION := 0
1347 END;
1348 MARKER := MARKER + 1
1349 END;
1350 MARKER := 1;
1351 WHILE (MARKER <= LINERRPTR) AND
1352 (LINERRORS[MARKER].ERRPOSITION = 0) DO
1353 MARKER := MARKER + 1;
1354 IF MARKER <= LINERRPTR THEN
1355 BEGIN
1356 WRITELN(TRANSLATE);
1357 LINEPOSITION := 0;
1358 WRITE(TRANSLATE, ' ');
1359 PAGELINECOUNT := PAGELINECOUNT + 1
1360 END
1361 ELSE
1362 BEGIN
1363 WRITELN(TRANSLATE);
1364 MOREERRORS := FALSE
1365 END
1366 END
1367 END; (* PRINTLINERRORS *)
1368
1369
1370
1371
1372
1373
1374
1375
1376
1377

```

```

PROCEDURE GPRINTTABLE;
(* THIS IS USED BY A TOGGLE IN THE INPUT IF *)
(* THE DETAILS OF THE PARSE ARE DESIRED IN *)
(* AN OUTPUT FILE CALLED TRANSLATE *)
VAR PTR : SYMPTR;
I, J : INTEGER;

```



```

1378 BEGIN
1379   FOR I := 1 TO TABSIZE DO
1380     BEGIN
1381       PTR := SYMTABLE[I];
1382       Writeln(translate, I : 5);
1383       WHILE PTR <> NIL DO
1384         BEGIN
1385           WRITE(translate, ' ');
1386           WRITE(translate, PTR.SYMNAM : 10, ' ');
1387           WITH PTR DO
1388             CASE KIND OF
1389               UNDEFINED : WRITE(translate, 'UNDEFINED');
1390               RESWD : WRITE(translate, 'RESWD', KEY1 : 5);
1391               BINARY : WRITE(translate, 'BINARY', PRECISION2 : 5,
1392                             IVAL2 : 5);
1393               ARITHMETIC : WRITE(translate, 'ARITHMETIC', PRECISION3 : 5,
1394                                IVAL3 : 5);
1395               WORD : WRITE(translate, 'TEXT', CODID4.SYMNAM : 10,
1396                           STRINGPTR4 : 5);
1397               CHAREP : WRITE(translate, 'CHARREP', CODID5.SYMNAM : 10,
1398                             IVAL5 : 5);
1399               TRANSDC : WRITE(translate, 'TRANSDC', TYPE6.SYMNAM : 10,
1400                             TECHNOLOGY6.SYMNAM : 10, PRECISION6 : 5);
1401               TASK : WRITE(translate, 'TASK');
1402               FNCTN : WRITE(translate, 'FUNCTION', TYPE8.SYMNAM : 10,
1403                             PRECISION8 : 5);
1404             END;
1405             Writeln(translate);
1406             PTR := PTR.LINK
1407           END;
1408           Writeln(translate)
1409         END
1410       END; (* GOPRINTTABLE *)
1411     END;
1412   (*-----*** GET INPUT SYMBOLS ***-----*)
1413
1414   PROCEDURE GETSYM (*VAR NESTSYM : INTEGER; VAR DES : DESCRIPTOR *);
1415     (* GETS THE NEXT INPUT SYMBOL AND DETERMINES *)
1416     (* THE TYPE AND DESCRIPTION OF THE TOKEN *)
1417
1418     VAR LEN. (* LENGTH OF INPUT SYMBOL *)
1419         I. (* INDEX *)
1420         BASE, (* BASE FOR BASED INTEGER *)
1421         NUMDIGITS, (* NUMBER OF DIGITS IN CURRENT INTEGER *)
1422         SCALE, (* EXPONENT ADJUSTMENT *)
1423         EXPONENT : INTEGER; (* INTEGER VAL OF EXPONENT *)
1424         SIGN, (* FLAG INDICATING NEGATIVE EXPONENT *)
1425         DECIMALFLAG, (* FLAG INDICATING RADIX PT *)
1426         BASENUMBER, (* FLAG INDICATING BASE OTHER THAN 10 *)
1427         ENDSTRING : BOOLEAN; (* FLAG INDICATING END OF STRING *)
1428         FAC, R : REAL; (* FOR EXPONENT ADJUSTMENT *)
1429
1430     FUNCTION FLIP (FLIPEE : BOOLEAN) : BOOLEAN;

```



```

1431 BEGIN
1432   IF FLIPEE = TRUE THEN
1433     FLIP := FALSE
1434   ELSE
1435     FLIP := TRUE
1436   END; (*FLIP*)
1437
1438 FUNCTION CHARVAL (CH : CHAR) : INTEGER;
1439 BEGIN
1440   IF CH IN ['A'..'F','0'..'9'] THEN
1441     CASE CH OF
1442       '0' : CHARVAL := 0;
1443       '1' : CHARVAL := 1;
1444       '2' : CHARVAL := 2;
1445       '3' : CHARVAL := 3;
1446       '4' : CHARVAL := 4;
1447       '5' : CHARVAL := 5;
1448       '6' : CHARVAL := 6;
1449       '7' : CHARVAL := 7;
1450       '8' : CHARVAL := 8;
1451       '9' : CHARVAL := 9;
1452       'A' : CHARVAL := 10;
1453       'B' : CHARVAL := 11;
1454       'C' : CHARVAL := 12;
1455       'D' : CHARVAL := 13;
1456       'E' : CHARVAL := 14;
1457       'F' : CHARVAL := 15
1458     END
1459   ELSE
1460     CHARVAL := 16
1461   END; (* CHARVAL *)
1462
1463 PROCEDURE INCHAR (VAR CH : CHAR);
1464 BEGIN
1465   IF CC = LL THEN
1466     BEGIN
1467       IF EOF(DAT) THEN
1468         BEGIN
1469           WRITELN(TRANSLATE,'GOING INTO ERROR IN INCHAR');
1470           ERROR(10,5,0)
1471         END;
1472       IF LINERRPTR <> 0 THEN
1473         BEGIN
1474           PRINTLINERRORS;
1475           LINERRPTR := 0;
1476           OVERFLOWLOGGED := FALSE
1477         END;
1478       LL := 0;
1479       CC := 0;
1480       IF PAGELINECOUNT MOD PAGESIZE = 0 THEN (* NEW PAGE *)
1481         BEGIN
1482           WRITELN(TRANSLATE,'1');
1483           HEADER

```



```

1484 END;
1485 SOURCELINECOUNT := SOURCELINECOUNT + 1;
1486 WRITE(TRANSLATE, SOURCELINECOUNT : 5, ' ');
1487 WHILE NOT EOLN(DAT) DO
1488 BEGIN
1489   LL := LL + 1;
1490   READ(DAT, CH);
1491   WRITE(TRANSLATE, CH);
1492   LINE[LL] := CH
1493 END;
1494 LL := LL + 1;
1495 LINE[LL] := ',' ;
1496 Writeln(TRANSLATE);
1497 READLN(DAT);
1498 PAGELINECOUNT := PAGELINECOUNT + 1
1499 END;
1500 CC := CC + 1;
1501 CH := LINE[CC];
1502 IF EOF(DAT) THEN
1503   IF CC = LL THEN
1504     LASTOK := TRUE
1505   END; (*INCHAR*)
1506
1507
1508 PROCEDURE GETNUMBER (VAR CH : CHAR; BASE : INTEGER;
1509   DECIMALPART : BOOLEAN; VAR DIGITS, IVALUE : INTEGER;
1510   VAR RVALUE : REAL);
1511 BEGIN
1512   DIGITS := 1;
1513   IF CHARVAL(CH) >= BASE THEN
1514     ERROR(7,1,0);
1515   IF DECIMALPART THEN
1516     RVALUE := RVALUE * BASE + CHARVAL(CH)
1517   ELSE
1518     IVALUE := CHARVAL(CH);
1519   INCHAR(CH);
1520   WHILE ((BASE = 10) AND (CH IN ['0'..'9','.'])) OR
1521     ((BASE <> 10) AND (CH IN ['0'..'9','A'..'Z','.'])) DO
1522     BEGIN
1523       IF CH = '.' THEN
1524         INCHAR(CH);
1525       IF DECIMALPART THEN
1526         RVALUE := RVALUE * BASE + CHARVAL(CH)
1527       ELSE
1528         IVALUE := IVALUE * BASE + CHARVAL(CH);
1529       DIGITS := DIGITS + 1;
1530       IF CHARVAL(CH) >= BASE THEN
1531         ERROR(7,1,0);
1532       INCHAR(CH)
1533     END
1534   END; (* GETNUMBER *)
1535
1536 PROCEDURE GETEXPONENT (VAR SIGN : BOOLEAN; VAR EXP : INTEGER);

```



```

1537 VAR NUMDIGITS, INTVAL : INTEGER;
1538 REALVAL : REAL;
1539 BEGIN
1540   SIGN := FALSE;
1541   INCHAR(CH);
1542   IF CH = '+' THEN
1543     INCHAR(CH)
1544   ELSE
1545     IF CH = '-' THEN
1546       BEGIN
1547         SIGN := TRUE;
1548         INCHAR(CH)
1549       END;
1550     IF CH IN ['0'..'9'] THEN
1551       BEGIN
1552         GETNUMBER(CH,10,FALSE,NUMDIGITS,INTVAL,REALVAL);
1553         EXP := INTVAL
1554       END
1555     ELSE
1556       BEGIN
1557         ERROR(4,1,0);
1558         EXP := 0
1559       END
1560     END;
1561
1562   BEGIN (* GETSYM *)
1563     DES.SYNAME := '
';
1564     DES.INTVAL := 0;
1565     DES.REALVAL := 0.0;
1566     DES.TMPNAME := '
';
1567     DES.CHARVAL := '@';
1568     DES.SYMLOC := NIL;
1569     DES.LINEPOS := LINELENGTH;
1570     BUFFER := '
';
1571     IF EOF(DAT) AND LASTTOK THEN
1572       NEXTSYM := ENDTOK
1573     ELSE
1574       WHILE CH = ' ' DO
1575         INCHAR(CH);
1576       CASE CH OF
1577         'A','B','C','D','E','F','G','H','I',
1578         'J','K','L','M','N','O','P','Q','R',
1579         'S','T','U','V','W','X','Y','Z' :
1580           BEGIN
1581             I := 1;
1582             BUFFER[I] := CH;
1583             INCHAR(CH);
1584             WHILE CH IN ['A'..'Z','0'..'9',' ',''] DO
1585               BEGIN
1586                 IF I < 10 THEN
1587                   I := I + 1;
1588                 BUFFER[I] := CH

```



```

1590 END;
1591 IF CH = '' THEN
1592 BEGIN
1593   INCHAR(CH);
1594   IF I < 10 THEN
1595     BEGIN
1596       I := I + 1;
1597       BUFFER[I] := CH
1598     END;
1599   IF NOT (CH IN ['A'..'Z','0'..'9']) THEN
1600     ERROR(2,1,0)
1601   END;
1602   INCHAR(CH)
1603 END;
1604 WHILE I < 10 DO
1605 BEGIN
1606   I := I + 1;
1607   BUFFER[I] := ' '
1608 END;
1609 (* IDENTIFIER OR RESERVED WORD *)
1610 DES.SYMLOC := LOOKUP(BUFFER);
1611 IF DES.SYMLOC <> NIL THEN
1612 BEGIN
1613   IF DES.SYMLOC.KIND = RESWD THEN
1614     BEGIN
1615       NEXTSYM := DES.SYMLOC.KEY1;
1616       DES.LINEPOS := CC - 1
1617     END
1618   ELSE
1619     NEXTSYM := IDTOK
1620   END
1621 ELSE
1622 BEGIN
1623   NEXTSYM := IDTOK;
1624   DES.SYMLOC := ENTER(BUFFER)
1625 END;
1626 DES.SYMNAME := DES.SYMLOC.SYMNAME
1627 END; (* CASE OF 'A'..'Z' *)
1628
1629 '0','1','2','3','4','5','6','7','8','9' :
1630 BEGIN
1631   NEXTSYM := NUMTOK;
1632   BASE := 10;
1633   SCALE := 0;
1634   DECIMALFLAG := FALSE;
1635   BASENUMBER := FALSE;
1636   GETNUMBER(CH,BASE,DECIMALFLAG,NUMDIGITS,DES.INTVAL,DES.REALVAL);
1637   IF CH = ' ' THEN (*BASED NUMBER*)
1638     BEGIN
1639       BASENUMBER := TRUE;
1640       BASE := DES.INTVAL;
1641       IF BASE > 16 THEN
1642         BEGIN

```



```

1643 ERROR(6,1,-1);
1644 BASE := 16
1645 END;
1646 INCHAR(CH);
1647 GETNUMBER(CH,BASE,DECIMALFLAG,NUMDIGITS,DES.INTVAL,DES.REALVAL);
1648 IF CH = '.' THEN
1649 BEGIN
1650     DECIMALFLAG := TRUE;
1651     DES.REALVAL := DES.INTVAL;
1652     DES.INTVAL := 0;
1653     DES.CHARVAL := 'R';
1654     INCHAR(CH);
1655     GETNUMBER(CH,BASE,DECIMALFLAG,NUMDIGITS,
1656     DES.INTVAL,DES.REALVAL);
1657     SCALE := -NUMDIGITS
1658 END;
1659 IF CH <> '.' THEN
1660     ERROR(3,1,0);
1661     INCHAR(CH)
1662 END;
1663 IF CH = '.' THEN (*DECIMAL PART *)
1664 BEGIN
1665     INCHAR(CH);
1666     IF BASEDNUMBER THEN
1667         ERROR(3,1,-1);
1668     DES.REALVAL := DES.INTVAL;
1669     DES.INTVAL := 0;
1670     DECIMALFLAG := TRUE;
1671     DES.CHARVAL := 'R';
1672     GETNUMBER(CH,BASE,DECIMALFLAG,NUMDIGITS,DES.INTVAL,DES.REALVAL);
1673     SCALE := -NUMDIGITS
1674 END;
1675 IF CH = 'E' THEN (* EXPONENT PART *)
1676 BEGIN
1677     DECIMALFLAG := FALSE;
1678     DES.CHARVAL := 'R';
1679     IF SCALE = 0 THEN
1680     DES.REALVAL := DES.INTVAL;
1681     GETEXPONENT(SIGN,EXPONENT);
1682     IF SIGN THEN
1683         SCALE := SCALE - EXPONENT
1684     ELSE
1685         SCALE := SCALE + EXPONENT
1686     END;
1687     IF SCALE <> 0 THEN (*ADJUST SCALE *)
1688     BEGIN
1689         R := 1;
1690         SIGN := SCALE < 0;
1691         SCALE := ABS(SCALE);
1692         FAC := BASE;
1693         REPEAT
1694             IF ODD(SCALE) THEN
1695                 R := R *FAC;

```



```

1696 FAC := SQR(FAC);
1697 SCALE := SCALE DIV 2
1698 UNTIL SCALE = 0;
1699 IF SIGN THEN
1700 DES.REALVAL := DES.REALVAL/R
1701 ELSE
1702 DES.REALVAL := DES.REALVAL * R
1703 END
1704 END; (* CASE OF '0'..'9' *)
1705
1706 '(', '+', '-', ',', ';', ':', '.', '{', '}', ' ' :
1707 BEGIN
1708 NEXTSYM := SPS[CH];
1709 DES.LINEPOS := CC;
1710 INCHAR(CH)
1711 END;
1712
1713 '""' :.. (* STRINGS *)
1714 BEGIN
1715 INCHAR(CH);
1716 ENDSTRING := FALSE;
1717 WHILE NOT ENDSTRING DO
1718 BEGIN
1719 WHILE CH <> '"' DO
1720 INCHAR(CH);
1721 INCHAR(CH);
1722 IF CH = '"' THEN
1723 INCHAR(CH)
1724 ELSE
1725 ENDSTRING := TRUE
1726 END;
1727 NEXTSYM := STRINGTOK
1728 END; (*STRINGS*)
1729
1730 '.,' :
1731 BEGIN
1732 INCHAR(CH);
1733 IF CH = '.,' THEN
1734 BEGIN
1735 INCHAR(CH);
1736 IF CH = '.,' THEN
1737 BEGIN
1738 INCHAR(CH);
1739 GETSYM(NEXTSYM,DES);
1740 IF NEXTSYM <> IDTOK THEN
1741 ERROR(17,1,-1)
1742 ELSE
1743 IF DES.SYMNAM = 'TRACEPARSE' THEN
1744 SWITCH[TRACEPARSE] := FLIP(SWITCH[TRACEPARSE])
1745 ELSE IF DES.SYMNAM = 'TRACETOK' THEN
1746 SWITCH[TRACETOK] := FLIP(SWITCH[TRACETOK])
1747 ELSE IF DES.SYMNAM = 'PRINTTABLE' THEN
1748 SWITCH[PRINTTABLE] := FLIP(SWITCH[PRINTTABLE])

```



```

1802  '//' :
1803  BEGIN
1804    INCHAR(CH);
1805    IF CH = '=' THEN
1806      BEGIN
1807        NEXTSYM := NOTEQTOK;
1808        INCHAR(CH)
1809      END
1810    ELSE
1811      NEXTSYM := SPS['//']
1812    END; (* CASE OF '// *')
1813
1814  '<' :
1815  BEGIN
1816    INCHAR(CH);
1817    IF CH = '=' THEN
1818      BEGIN
1819        NEXTSYM := LESSEQTOK;
1820        INCHAR(CH)
1821      END
1822    ELSE
1823      NEXTSYM := SPS['<']
1824    END; (* CASE OF '<' *')
1825
1826  '>' :
1827  BEGIN
1828    INCHAR(CH);
1829    IF CH = '=' THEN
1830      BEGIN
1831        NEXTSYM := GTREQTOK;
1832        INCHAR(CH)
1833      END
1834    ELSE
1835      NEXTSYM := SPS['>']
1836    END; (* CASE OF '>' *')
1837
1838  '','','$',' ','%','','','?','@','','','' :
1839  BEGIN
1840    ERROR(11,1,0);
1841    INCHAR(CH);
1842    GETSYM(NEXTSYM,DES)
1843  END
1844  END (* CASE *)
1845  END; (* GETSYM *)
1846
1847
1848
1849
1850
1851
1852
1853
1854

```

```

PROCEDURE SEMANTIC (*PRODUCTION : INTEGER*);
(* SEMANTIC AND SEMANTIC1 PERFORM THE STACK *)
(* MANIPULATION BASED ON THE CURRENT PRO- *)
(* Duction NUMBER AND WILL EMIT THE PROPER *)
(* VALUES TO THE PRIMITIVE LIST, SYMBOL *)
(* TABLE AND TRANSLATE FILES *)

```



```

1855 VAR PTR : SYMPTR;
1856
1857 TYPVAR : EXPTYPES;
1858 TEMPNAME : ALFA;
1859 PRCSN, I : INTEGER;
1860
1861 BEGIN
1862   CASE PRODUCTION OF
1863     2, 3,
1864       (* <AOP> ::= +/- *)
1865       (* <MOP> ::= *// *)
1866       (* <RELATIONAL OP> ::= </<=</>/>=</>=// = *)
1867       STACK[STKPTR].DES.INTVAL := PRODUCTION;
1868
1869   12:
1870     (* <PRIMARY> ::= <NUMBER> *)
1871     IF STACK[STKPTR].DES.CHARVAL = '@' THEN
1872       (* INTEGER *)
1873       BEGIN
1874         NEWCONS(STACK[STKPTR].DES.INTVAL, TEMPNAME, PRCSN);
1875         PUSHEVALSTACK(TEMPNAME, PRCSN);
1876         STACK[STKPTR].EXPTYPE := INT
1877       END
1878     ELSE
1879       BEGIN
1880         ERROR(18,1,-3);
1881         PUSHEVALSTACK('JUNK',8);
1882         STACK[STKPTR].EXPTYPE := REEL
1883       END;
1884
1885   13:
1886     (* <PRIMARY> ::= *STRING* *)
1887     BEGIN
1888       STACK[STKPTR].EXPTYPE := STNG;
1889       PUSHEVALSTACK('STRING',8)
1890     END;
1891
1892   14:
1893     (* <PRIMARY> ::= <NAME> *)
1894     BEGIN
1895       WITH STACK[STKPTR].DES.SYMLOC DO
1896         CASE KIND OF TRANSDEC, ARITHMETIC, UNDEFINED:
1897           BEGIN
1898             IF KIND = TRANSDEC THEN
1899               PUSHEVALSTACK(SYMNAM,PRECISION6)
1900             ELSE
1901               IF KIND = ARITHMETIC THEN
1902                 PUSHEVALSTACK(SYMNAM,PRECISION3)
1903               ELSE
1904                 BEGIN
1905                   PUSHEVALSTACK(SYMNAM,8);
1906                   ERROR(28,1,-3)
1907                 END;
1908               STACK[STKPTR].EXPTYPE := INT
1909             END;
1910             FNCTN:
1911             BEGIN
1912               IF TYPE8.SYMNAM <> 'ARITHMETIC' THEN
1913                 ERROR(27,1,-3);

```



```

1908 PUSHEVALSTACK(SYMMNAME,PRECISION8);
1909 STACK[STKPTR].EXPTYPE := INT
1910 END;
1911 OTHERWISE
1912 BEGIN
1913   ERROR(27,1,-3);
1914   PUSHEVALSTACK('JUNK',8);
1915   STACK[STKPTR].EXPTYPE := INT
1916 END
1917 END;
1918
1919
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15:      (* <PRIMARY> ::= ( <EXPRESSION> ) *)
      (* RETAIN INFORMATION ON EXPRESSION *)
      BEGIN
        STACK[STKPTR - 2] := STACK[STKPTR - 1]
      END;

16:      ;      (* <FACTOR> ::= <PRIMARY> *)

17:      ;      (* <FACTOR> ::= <FACTOR> ** <PRIMARY> *)

18:      ;      (* <TERM> ::= <FACTOR> *)

19:      (* <TERM> ::= <TERM> <MOP> <FACTOR> *)
23:      (* <SIMPLE EXP> ::= <SIMPLE EXP> <AOP> <TERM> *)
25:      (* <SIMPLE EXP> ::= <SIMPLE EXP> <RELATIONAL OP> <SIMPLE EXP> *)
      BEGIN
        TYPVAR := CHECKTYPE(STACK[STKPTR - 2].EXPTYPE,
          STACK[STKPTR].EXPTYPE);
        POPEVALSTACK(OPSTORE[3],SELSTORE[3]);
        POPEVALSTACK(OPSTORE[2],SELSTORE[2]);
        SELSTORE[1] := COMPUTPRE(SELSTORE[2],SELSTORE[3]);
        NEWTEMP(SELSTORE[1],OPSTORE[1]);
        PUSHEVALSTACK(OPSTORE[1],SELSTORE[1]);
        CASE TYPVAR OF
          INT: CASE STACK[STKPTR-1].DES.INTVAL OF
            2 : (* + *) PUTS('add',3,3);
            3 : (* - *) PUTS('sub',3,3);
            4 : (* * *) PUTS('mult',3,3);
            5 : (* / *) PUTS('divide',3,3);
            6 : (* < *) PUTS('lt',3,3);
            7 : (* <= *) PUTS('le',3,3);
            8 : (* = *) PUTS('eq',3,3);
            9 : (* > *) PUTS('gt',3,3);
            10 : (* >= *) PUTS('ge',3,3);
            11 : (* /= *) PUTS('ne',3,3);
          END;
          (*CASE OF STACK*)
          STNG : ERROR(19,0,-1);
          BOOL : ERROR(21,0,-1);
          ERRORS : ERROR(20,0,-1);
        END;
        (* CASE OF TYPEVAR *)
        IF STACK[STKPTR-1].DES.INTVAL IN [6..13] THEN

```



```

1961 STACK[STKPTR-2].EXPTYPE := BOOL;
1962 END;
1963
1964 20 :      (* <SIMPLE EXP> ::= <TERM> *) ;
1965
1966 21 :      (* <SIMPLE EXP> ::= <AOP><TERM> *)
1967 IF STACK[STKPTR].EXPTYPE <> INT THEN
1968   ERROR(20,1,-1)
1969 ELSE
1970   IF STACK[STKPTR - 1].DES.INTVAL = 3 THEN  (*UNARY MINUS*)
1971     BEGIN
1972       POPEVALSTACK(OPSTORE[3],SELSTORE[3]);
1973       NEWCONS(0,OPSTORE[2],SELSTORE[2]);
1974       SELSTORE[1] := COMPUTPRE(SELSTORE[2],SELSTORE[3]);
1975       NEWTEMP(SELSTORE[1],OPSTORE[1]);
1976       PUTS('sub',3,3);
1977       PUSHEVALSTACK(OPSTORE[1],SELSTORE[1])
1978     END;
1979
1980 22 :      (* <SIMPLE EXP> ::= NOT TERM *)
1981 IF STACK[STKPTR].EXPTYPE <> BOOL THEN
1982   ERROR(20,1,-1)
1983 ELSE
1984   BEGIN  (*GENERATE NOT*)
1985     POPEVALSTACK(OPSTORE[2],SELSTORE[2]);
1986     NEWTEMP(SELSTORE[2], OPSTORE[1]);
1987     (* PRECISION, TEMPNAME *)
1988     PUSHEVALSTACK(OPSTORE[1],SELSTORE[1]);
1989     PUTS('not',2,2)
1990   END;
1991
1992 24 :      (* <RELATION> ::= <SIMPLE EXP> *) ;
1993
1994 26 :      (* <EXP4> ::= <RELATION> *) ;
1995
1996 27,      (* <EXP4> ::= <EXP4> AND <RELATION> *)
1997 29,      (* <EXP3> ::= <EXP3> OR <EXP4> *)
1998 31,      (* <EXP2> ::= <EXP-2>=> <EXP3> *)
1999 33 :      (* <EXPRESSION> ::= <EXPRESSION> == <EXP2> *)
2000
2001 BEGIN
2002   TVPVAR := CHECKTYPE(STACK[STKPTR - 2].EXPTYPE,
2003     STACK[STKPTR].EXPTYPE);
2004   POPEVALSTACK(OPSTORE[3],SELSTORE[3]);
2005   POPEVALSTACK(OPSTORE[2],SELSTORE[2]);
2006   SELSTORE[1] := COMPUTPRE(SELSTORE[3],SELSTORE[2]);
2007   NEWTEMP(SELSTORE[1],OPSTORE[1]);
2008   PUSHEVALSTACK(OPSTORE[1],SELSTORE[1]);
2009   CASE TVPVAR OF
2010     BOOL : CASE PRODUCTION OF
2011       27 : PUTS('and',3,3);
2012       29 : PUTS('or',3,3);
2013       31 : PUTS('imply',3,3);
2014       33 : PUTS('equivalenc',3,3);

```



```

2014 END;
2015 INT : ERROR(23,1,-1);
2016 STNG : ERROR(19,1,-1);
2017 ERRORS : ERROR(20,1,-1)
2018 END
2019 END;
2020
2021 28 : (* <EXP3> ::= <EXP4> *) ;
2022
2023 30 : (* <EXP2> ::= <EXP3> *) ;
2024
2025 32 : (* <EXPRESSION> ::= <EXP2> *) ;
2026
2027 34 : (* <EXPR LIST> ::= *)
2028 STACK[STKPTR + 1].DES.INTVAL := 0;
2029
2030 35 : (* <EXPR LIST> ::= <EXPRESSION> *)
2031 STACK[STKPTR].DES.INTVAL := 1;
2032
2033 36 : (* <EXPR LIST> ::= <EXPR LIST>, <EXPRESSION> *)
2034 STACK[STKPTR-2].DES.INTVAL := STACK[STKPTR-2].DES.INTVAL + 1;
2035
2036 37 : (* <IF THEN> ::= <IF HEAD> THEN <STMT GP> END IF *)
2037 BEGIN
2038 OPSTORE[1] := STACK[STKPTR - 4].DES.SYMNAME;
2039 PUTS('loc
2040 ',1,0);
2041 PUTSYM('LOC
2042 ',1,0)
2043 END;
2044
2045 38 : (* <IF HEAD> ::= IF <EXPRESSION> *)
2046 BEGIN
2047 IF STACK[STKPTR].EXPTYPE <> BOOL THEN
2048 BEGIN
2049 ERROR(26,1,-1);
2050 STACK[STKPTR].EXPTYPE := BOOL
2051 END;
2052 POPEVALSTACK(OPSTORE[1],SELSTORE[1]);
2053 NEWLABEL(OPSTORE[2]);
2054 PUTS('jmpf
2055 ',2,1);
2056 STACK[STKPTR - 1].DES.SYMNAME := OPSTORE[2]
2057 END;
2058
2059 39 : (* <WHILE DO> ::= <WHILE HEAD>DO<STMT GP>END WHILE *)
2060 BEGIN
2061 OPSTORE[1] := STACK[STKPTR - 4].DES.SYMNAME;
2062 OPSTORE[2] := STACK[STKPTR - 4].DES.TMPNAME;
2063 PUTS('whend
2064 ',2,0)
2065 END;
2066
2067 40 : (* <WHILE HEAD> ::= <WHILE><EXPRESSION>;<MAXLOOPCOUNT> *)
2068 BEGIN
2069 POPEVALSTACK(OPSTORE[1],SELSTORE[1]);
2070 NEWLABEL(OPSTORE[2]);

```



```

2067 STACK(STKPTR - 3).DES.TMPNAME := OPSTORE[2];
2068 SELSTORE[1] := STACK(STKPTR).DES.INTVAL;
2069 PUTS('whitecon ',2,1)
2070 END;
2071
2072 41 : (* <WHILE> ::= WHILE *)
2073 BEGIN
2074   NEWLABEL(OPSTORE[1]);
2075   STACK(STKPTR).DES.SYMNAME := OPSTORE[1];
2076   PUTS('whitestart',1,0)
2077 END;
2078
2079 42 : (* <FOR LOOP> ::= <FOR HEAD>DO<STMT GP>END FOR *)
2080 WITH STACK(STKPTR - 4) DO
2081 BEGIN
2082   OPSTORE[1] := DES.SYMLOC.SYMNAME;
2083   SELSTORE[1] := DES.SYMLOC.PRECISION3;
2084   OPSTORE[2] := DES.SYMNAME;
2085   OPSTORE[3] := DES.TMPNAME;
2086   SELSTORE[2] := DES.INTVAL;
2087   PUTS('forend ',3,2)
2088 END;
2089
2090 43 : (* <FORHEAD> ::= FOR *ID* FROM <EXPRESSION> TO *)
2091 (* <EXPRESSION> : <MAXLOOPCOUNT> *)
2092 BEGIN
2093   IF STACK(STKPTR - 6).DES.SYMLOC.KIND <> ARITHMETIC THEN
2094     ERROR(29,1,-1);
2095   OPSTORE[1] := STACK(STKPTR - 6).DES.SYMNAME;
2096   SELSTORE[1] := STACK(STKPTR - 6).DES.SYMLOC.PRECISION3;
2097   POPEVALSTACK(OPSTORE[3],SELSTORE[3]);
2098   POPEVALSTACK(OPSTORE[2],SELSTORE[2]);
2099   NEWLABEL(OPSTORE[4]);
2100   NEWLABEL(OPSTORE[5]);
2101   SELSTORE[4] := STACK(STKPTR).DES.INTVAL;
2102   PUTS('forcons ',5,4);
2103   STACK(STKPTR - 7).DES.SYMNAME := OPSTORE[4];
2104   STACK(STKPTR - 7).DES.TMPNAME := OPSTORE[5];
2105   STACK(STKPTR - 7).DES.SYMLOC := STACK(STKPTR - 6).DES.SYMLOC;
2106   STACK(STKPTR - 7).DES.INTVAL := SELSTORE[4]
2107 END;
2108
2109 44 : (* <PERFORM TASK> ::= *ID* *)
2110 BEGIN
2111   IF (STACK(STKPTR).DES.SYMLOC.KIND <> TASK) AND
2112     (STACK(STKPTR).DES.SYMLOC.KIND <> FUNCTN) THEN
2113     ERROR(24,1,-1);
2114   OPSTORE[1] := STACK(STKPTR).DES.SYMNAME;
2115   PUTS('call ',1,0)
2116 END;
2117
2118 45 : (* <PERFORM TASK> ::= <ID> ( <EXPR LIST> : <ID LIST> ) *)
2119 BEGIN

```



```

2120 ERROR(36,1,-1);
2121 IF (STACK[STKPTR - 5].DES.SYMLOC.KIND <> TASK) AND
2122 (STACK[STKPTR - 5].DES.SYMLOC.KIND <> FNCTN) THEN
2123 ERROR(24,1,STACK[STKPTR - 4].DES.LINEPOS - CC - 3);
2124 OPSTORE[1] := STACK[STKPTR].DES.SYMNAME;
2125 PUTS('call ',1,0)
2126 END;
2127
2128 (* <MAXLOOPCOUNT> ::= <NUMBER> *)
2129 IF STACK[STKPTR].DES.CHARVAL <> '@' (*INTEGER*) THEN
2130 ERROR(13,1,-1);
2131
2132 (* <LEFT PART LIST> ::= <NAME> := *)
2133 BEGIN
2134   TEMPLIST[1] := STACK[STKPTR - 1].DES.SYMLOC;
2135   TLI := 1
2136 END;
2137
2138 (* <LEFT PART LIST> ::= <LEFT PART LIST> <NAME> := *)
2139 BEGIN
2140   TLI := TLI + 1;
2141   TEMPLIST[TLI] := STACK[STKPTR - 1].DES.SYMLOC
2142 END;
2143
2144 (* <ASSIGNMENT STATEMENT> ::= <LEFT PART LIST><EXPRESSION>*)
2145 BEGIN
2146   POPEVALSTACK(OPSTORE[2],SELSTORE[2]);
2147   FOR I := 1 TO TLI DO
2148     BEGIN
2149       OPSTORE[1] := TEMPLIST[I].SYMNAME;
2150       WITH TEMPLIST[I] DO
2151         CASE KIND OF
2152           BINARY: SELSTORE[1] := PRECISION2;
2153           ARITHMETIC: SELSTORE[1] := PRECISION3;
2154           TRANSEC: SELSTORE[1] := PRECISION6;
2155           FNCTN: SELSTORE[1] := PRECISION8;
2156           OTHERWISE BEGIN
2157             ERROR(32,1,-1);
2158             SELSTORE[1] := 8
2159           END
2160         END
2161       END;
2162       PUTS('assign ',2,2)
2163     END;
2164
2165     (* <DATA INPUT> ::= SENSE ( <NAME> ) *)
2166     WITH STACK[STKPTR - 1].DES.SYMLOC DO
2167       CASE KIND OF
2168         TRANSEC : IF TYPE6.SYMNAME <> 'INPUT ' THEN
2169           ERROR(20,1,2)
2170         ELSE BEGIN
2171           OPSTORE[1] := SYMNAME;
2172           SELSTORE[1] := PRECISION6;

```



```

2173 PUTS('sensecond ',1,1)
2174 END;
2175 UNDEFINED : ERROR(28,1,-2);
2176 OTHERWISE ERROR(20,1,-2)
2177 END;
2178
2179 (* <DATA OUTPUT> ::= ISSUE (<NAME>) *)
2180 WITH STACK[STKPTR - 1].DES.SYMLOC DO
2181 CASE KIND OF
2182 TRANSDEC : IF TYPE6.SYNAME <> 'OUTPUT' THEN
2183 ERROR(20,1,-2)
2184 ELSE BEGIN
2185 OPSTORE[1] := SYNAME;
2186 SELSTORE[1] := PRECISION6;
2187 PUTS('issuevent ',1,1)
2188 END;
2189 OTHERWISE ERROR(20,1,-2)
2190 END;
2191
2192 52,53,54,55,56,57 : (* <TIME MEASURE> ::= H/M/S/MS/US/NS *)
2193 STACK[STKPTR].DES.INTVAL := PRODUCTION;
2194
2195 58 : (* <PERIOD> ::= <NUMBER><TIME MEASURE> *)
2196 BEGIN
2197 IF STACK[STKPTR - 1].DES.CHARVAL = '@' THEN
2198 STACK[STKPTR-1].DES.REALVAL := STACK[STKPTR-1].DES.INTVAL;
2199 WITH STACK[STKPTR - 1] DO
2200 CASE STACK[STKPTR].DES.INTVAL OF
2201 (* CONVERT ALL TIMES TO MILLISECONDS *)
2202 52 : (*HOURS*) DES.REALVAL := DES.REALVAL * 3600000;
2203 53 : (*MINUTES*) DES.REALVAL := DES.REALVAL * 60000;
2204 54 : (*SECONDS*) DES.REALVAL := DES.REALVAL * 1000;
2205 55 : (*MILLISECONDS*);
2206 56 : (*MICROSECONDS*) DES.REALVAL := DES.REALVAL/1000;
2207 57 : (* NANOSECONDS*) DES.REALVAL := DES.REALVAL/1000000
2208 END
2209 END;
2210
2211 (* <TIME> ::= <PERIOD> *) ;
2212
2213 (* <TIME> ::= <TIME><PERIOD> *)
2214 STACK[STKPTR-1].DES.REALVAL := STACK[STKPTR-1].DES.REALVAL +
2215 STACK[STKPTR].DES.REALVAL;
2216
2217 61 : (* <TIMED BLOCK> ::= <TIMEDBLOCKHEAD> ; <STMT GP>END IN *)
2218 PUTS('nt
2219 ',0,0);
2220
2221 (* <TIMEDBLCKHEAD> ::= IN <PERIOD> *)
2222 BEGIN
2223 SELSTORE[1] := TRUNC(STACK[STKPTR].DES.REALVAL);
2224 PUTS('in
2225 ',0,1)
2226 END;

```



```

2226 63 :      (* <WAIT> ::= WAIT <PERIOD> *)
2227 BEGIN
2228   SELSTORE[1] := TRUNC(STACK[STKPTR].DES.REALVAL);
2229   PUTS('fixedwait',0,1)
2230 END;
2231
2232 64 :      (* <WAIT> ::= WAIT <EXPRESSION> : <PERIOD> *)
2233 BEGIN
2234   POPEVALSTACK(OPSTORE[1],SELSTORE[1]);
2235   SELSTORE[2] := TRUNC(STACK[STKPTR].DES.REALVAL);
2236   PUTS('waitleast',1,2);
2237   IF STACK[STKPTR - 2].EXPTYPE <> INT THEN
2238     ERROR(38,1,STACK[STKPTR - 1].DES.LINEPOS - CC - 3)
2239   END;
2240
2241 65 :      (* <WAIT UNTIL> ::= <WAITHEAD><EXPRESSION> : <PERIOD> *)
2242 BEGIN
2243   POPEVALSTACK(OPSTORE[1],SELSTORE[1]);
2244   OPSTORE[2] := STACK[STKPTR - 3].DES.SYMNAM;
2245   NEWLABEL(OPSTORE[3]);
2246   SELSTORE[2] := TRUNC(STACK[STKPTR].DES.REALVAL);
2247   PUTS('boolwait',3,2);
2248   IF STACK[STKPTR - 2].EXPTYPE <> BOOL THEN
2249     ERROR(26,1,STACK[STKPTR - 1].DES.LINEPOS - CC - 3)
2250   END;
2251
2252 66 :      (* <WAITHEAD> ::= WAIT UNTIL *)
2253 BEGIN
2254   NEWLABEL(OPSTORE[1]);
2255   PUTS('stboolwait',1,0);
2256   STACK[STKPTR - 1].DES.SYMNAM := OPSTORE[1]
2257 END
2258
2259   OTHERWISE SEMANTIC1(PRODUCTION);
2260 END (*CASE*)
2261 END; (*SEMANTIC*)
2262
2263 PROCEDURE SEMANTIC1 (*PRODUCTION : INTEGER *);
2264 VAR PTR : SYMPTR;
2265     TVPVAR : EXPTYPES;
2266     TEMPNAME : ALFA;
2267     I : INTEGER;
2268
2269 BEGIN
2270   CASE PRODUCTION OF
2271
2272     86 : (*<INPUT SPEC> ::= INPUT : <TRANSMISSION BODY> END INPUT*)
2273     BEGIN
2274       FOR I := 1 TO TLI DO
2275         BEGIN
2276           TEMPLIST[I].TYPE6 := STACK[STKPTR - 4].DES.SYMLLOC;
2277
2278

```



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2279 OPSTORE[1] := TEMPLIST[1].SYMNAME;
2280 OPSTORE[2] := TEMPLIST[1].TECHNOLOGY6.SYMNAME;
2281 SELSTORE[1] := TEMPLIST[1].PRECISION6;
2282 PUTS('inputport',2,1);
2283 PUTSYM('INPUTPORT',2,1)
2284 END;
2285 TLI := 0
2286 END;
2287
2288 87 : (* <OUTPUT SPEC> ::= OUTPUT : *)
2289      (* <TRANSMISSION BODY> END OUTPUT *)
2290      BEGIN (* ASSIGN TYPE = 'OUTPUT' *)
2291          FOR I := 1 TO TLI DO
2292              BEGIN
2293                  TEMPLIST[I].TYPE6 := STACK[STKPTR - 4].DES.SYMLOC;
2294                  OPSTORE[1] := TEMPLIST[1].SYMNAME;
2295                  OPSTORE[2] := TEMPLIST[1].TECHNOLOGY6.SYMNAME;
2296                  SELSTORE[1] := TEMPLIST[1].PRECISION6;
2297                  PUTS('outputport',2,1);
2298                  PUTSYM('OUTPUTPORT',2,1)
2299              END;
2300              TLI := 0
2301          END;
2302
2303 94 : (* <DUPLEX SPEC> ::= DUPLEX : *)
2304      (* <TRANSMISSION BODY> END DUPLEX *)
2305      BEGIN (* ASSIGN TYPE = 'DUPLEX' *)
2306          FOR I := 1 TO TLI DO
2307              BEGIN
2308                  TEMPLIST[I].TYPE6 := STACK[STKPTR - 4].DES.SYMLOC;
2309                  OPSTORE[1] := TEMPLIST[1].SYMNAME;
2310                  OPSTORE[2] := TEMPLIST[1].TECHNOLOGY6.SYMNAME;
2311                  SELSTORE[1] := TEMPLIST[1].PRECISION6;
2312                  PUTS('in/outputport',2,1);
2313                  PUTSYM('IN/OUTPUTPORT',2,1)
2314              END;
2315              TLI := 0
2316          END;
2317
2318 95 : (* <BINARY SPEC> ::= BINARY : <BINARY BODY> END BINARY *);
2319
2320 96 :      (* <ARITHMETIC SPEC> ::=
2321          ARITHMETIC : <ARITHMETIC BODY> END ARITHMETIC *);
2322
2323 99 :      (* <TRANSMISSION DEC> ::= <ID> , <BINARY PRECISION> ,
2324          <TECHNOLOGY> *)
2325      BEGIN
2326          PTR := STACK[STKPTR - 4].DES.SYMLOC;
2327          IF PTR.KIND <> UNDEFINED THEN
2328              ERROR(14,1,STACK[STKPTR - 3].DES.INTVAL - 1);
2329          PTR.KIND := TRANSDEC;
2330          PTR.PRECISION6 := STACK[STKPTR - 2].DES.INTVAL;
2331          PTR.TECHNOLOGY6 := STACK[STKPTR].DES.SYMLOC

```



```

2332 END;
2333
2334 102 : (* <BINARY DEC> ::= <ID><STRUCTURE> , *)
2335      (* <BINARY PRECISION> <INITIAL VALUE> *)
2336 BEGIN
2337   PTR := STACK[STKPTR - 4].DES.SYMLOC;
2338   IF PTR.KIND <> UNDEFINED THEN
2339     ERROR(14,1,0);
2340   PTR.KIND := BINARY;
2341   PTR.PRECISION2 := STACK[STKPTR - 1].DES.INTVAL;
2342   IF STACK[STKPTR].DES.CHARVAL = '@' THEN
2343     PTR.IVAL2 := 0
2344   ELSE
2345     PTR.IVAL2 := STACK[STKPTR].DES.INTVAL
2346   END;
2347
2348 105 : (* <ARITHMETIC DEC> ::= <ID><STRUCTURE> , *)
2349      (* <DECIMAL PRECISION> <INITIAL VALUE> , *)
2350 BEGIN
2351   PTR := STACK[STKPTR - 4].DES.SYMLOC;
2352   IF PTR.KIND <> UNDEFINED THEN
2353     ERROR(14,1,0);
2354   PTR.KIND := ARITHMETIC;
2355   PTR.PRECISION3 := STACK[STKPTR - 1].DES.INTVAL;
2356   IF STACK[STKPTR].DES.CHARVAL = '@' THEN
2357     PTR.IVAL3 := 0
2358   ELSE
2359     PTR.IVAL3 := STACK[STKPTR].DES.INTVAL;
2360   OPSTORE[1] := PTR.SYMNAM;
2361   SELSTORE[1] := PTR.PRECISION3;
2362   SELSTORE[2] := PTR.IVAL3;
2363   PUTS('var ',1,2);
2364   PUTSYM('VARIABLE ',1,2)
2365   END;
2366
2367 106 :      (* <STRUCTURE> ::= *);
2368
2369 107 :      (* <STRUCTURE> ::= ( <NUMBER LIST> ) *)
2370      ERROR(36,1,-1);
2371
2372 108 ,      (* <NUMBER LIST> ::= *NUMBER* *)
2373
2374 109 :      (* <NUMBER LIST> ::= <NUMBER LIST> , *NUMBER* *)
2375 BEGIN
2376   IF STACK[STKPTR].DES.CHARVAL <> '@' THEN
2377     ERROR(18,1,-1);
2378   NLI := NLI + 1;
2379   SELSTORE[NLI] := STACK[STKPTR].DES.INTVAL;
2380   IF PRODUCTION = 111 THEN
2381     STACK[STKPTR].DES.INTVAL := NLI
2382   ELSE
2383     STACK[STKPTR - 2].DES.INTVAL := NLI
2384   END;

```



```

2385 110 :      (* <BINARY PRECISION> ::= <NUMBER> *)
2386 IF STACK[STKPTR].DES.CHARVAL <> '@' THEN
2387 ERROR(13,1,-1);
2388
2389 111 :      (* <DECIMAL PRECISION> ::= <NUMBER> *)
2390 IF STACK[STKPTR].DES.CHARVAL <> '@' THEN
2391 ERROR(18,1,-1);
2392
2393 112 :      (* <INITIAL VALUE> *)
2394 STACK[STKPTR + 1].DES.CHARVAL := '@';
2395
2396 113 :      (* <INITIAL VALUE> ::= <NUMBER> *)
2397 IF STACK[STKPTR].DES.CHARVAL = '@' THEN
2398 BEGIN
2399   STACK[STKPTR - 1].DES.CHARVAL := 'I';
2400   STACK[STKPTR - 1].DES.INTVAL := STACK[STKPTR].DES.INTVAL
2401 END
2402 ELSE
2403 ERROR(18,1,-1);
2404
2405 114,115,116 :      (* <TECHNOLOGY> ::= TTL/ECL/IIL *)
2406
2407 121 :      (* <CODE SPEC> ::= CODE : *ID* , <BINARY PRECISION> ;
2408           <CHARACTER REP LIST> END CODE *)
2409 BEGIN
2410   FOR I := 1 TO TLI DO
2411     TEMPLIST[1].CODID5 := STACK[STKPTR - 6].DES.SYMLOC;
2412     TLI := 0
2413   END;
2414
2415 97,98,118,119,122,123 :      (* <A> ::= <B> , <A> ::= <A> <B> *)
2416 BEGIN
2417   TLI := TLI + 1;
2418   TEMPLIST[TLI] := STACK[STKPTR - 1].DES.SYMLOC
2419 END;
2420
2421 125,126,127,128,129 :      (* <CODE ID> ::= <ID>/ASCII16/
2422           ASCII7/EBCDIC/BCD *)
2423
2424 130 :      (* <ID LIST> ::= *)
2425 TLI := 0;
2426
2427 131 :      (* <IDLIST> ::= <ID> *)
2428 BEGIN
2429   TEMPLIST[1] := STACK[STKPTR].DES.SYMLOC;
2430   TLI := 1
2431 END;
2432
2433 132 :      (* <ID LIST> ::= <IDLIST> , <ID> *)
2434 BEGIN
2435   TLI := TLI + 1;
2436   TEMPLIST[TLI] := STACK[STKPTR].DES.SYMLOC
2437

```



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2481
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2487
2488
2489
2490

END;

133 :      (* <NAME> ::= <ID> *);
134 :      (* <NAME> ::= <ID> ( <EXPRLIST> ) *)
      BEGIN
135 :      STACK[STKPTR - 3].DES.CHARVAL := 'A' ; (*ARRAY*)
136 :      ERROR(36,1,-1)
137 :      END;

135 :
      BEGIN
136 :      STACK[STKPTR - 5].DES.CHARVAL := 'B' ; (*BIT FIELD*)
137 :      ERROR(37,1,-1)
138 :      END;

136 :      (* <FORMAL PARAM LIST> ::= * )
137 :      FIRSTPARAM := NIL;
138 :      (* <FORMAL PARAM LIST> ::= ( <ID LIST> : <ID LIST> ) *)
139 :      ERROR(33,1,-1);

138 :      (* <PROC> ::= <TASK> *);
139 :      (* <PROC> ::= <FUNCTION> *);
140 :      (* <TASK> ::= <TASK HEAD> ; <ZOPT PROC DEC GP>
141 :      <STMT GP> END <ID> *)
142 :
146 :      (* <FUNCTION> ::= <FUNCTION HEAD> ; <ZOPT PROC DEC GP>
147 :      <STMT GP> END <ID> *)
148 :      BEGIN
149 :      IF STACK[STKPTR - 5].DES.SYMLOC <> STACK[STKPTR].DES.SYMLOC
150 :      THEN ERROR(25,1,-1);
151 :      OPSTORE[1] := STACK[STKPTR - 5].DES.SYMNAME;
152 :      PUTS('exitproc ',1,0)
153 :      END;

147 :      (* <FUNCTION HEAD> ::= FUNCTION *ID* <FORMAL PARAM LIST>
148 :      BINARY , <BINARY PRECISION><INITIAL VALUE> *)
149 :
150 :      (* <FUNCTION HEAD> ::= FUNCTION *ID* <FORMAL PARAM LIST>
151 :      ARITHMETIC , <DECIMAL PRECISION><INITIAL VALUE> *)
152 :      BEGIN
153 :      PUTT(STACK[STKPTR - 6].DES.SYMNAME);
154 :      OPSTORE[1] := STACK[STKPTR - 6].DES.SYMNAME;
155 :      PUTS('proc ',1,0);
156 :      WITH STACK[STKPTR - 6].DES.SYMLOC DO
157 :      BEGIN
158 :      KIND := FNCTN;
159 :      PARAMLIST8 := FIRSTPARAM;
160 :      TYPEB := STACK[STKPTR - 3].DES.SYMLOC;
161 :      PRECISION8 := STACK[STKPTR - 1].DES.INTVAL;

```



```

2491 IVALB := STACK[STKPTR].DES.INTVAL
2492 END;
2493 STACK[STKPTR - 7] := STACK[STKPTR - 6]
2494 END;
2495
2496 (* <TASK HEAD> ::= TASK *ID* <FORMAL PARAM LIST> *)
2497 BEGIN
2498   PUTT(STACK[STKPTR - 1].DES.SYMNAM);
2499   OPSTORE[1] := STACK[STKPTR - 1].DES.SYMNAM;
2500   PUTS('proc', 1, 0);
2501   WITH STACK[STKPTR - 1].DES.SYMLOC DO
2502     BEGIN
2503       KIND := TASK;
2504       PARAMLIST7 := FIRSTPARAM
2505     END;
2506     STACK[STKPTR - 2] := STACK[STKPTR - 1]
2507   END;
2508
2509 (* <RANK> ::= <NU> *)
2510 STACK[STKPTR].DES.LINEPOS := STACK[STKPTR].DES.INTVAL;
2511
2512 (* <RANK> ::= <NU> . <PI> *)
2513 BEGIN
2514   STACK[STKPTR - 2].DES.LINEPOS :=
2515     STACK[STKPTR - 2].DES.INTVAL;
2516   STACK[STKPTR - 2].DES.INTVAL := STACK[STKPTR].DES.INTVAL
2517 END;
2518
2519 (* <NU> ::= <NUMBER> *)
2520 (* <PI> ::= <NUMBER> *)
2521 IF STACK[STKPTR].DES.CHARVAL <> '@' THEN
2522   ERROR(13, 1, -1);
2523
2524 (* <QUALIFICATION> ::= * *)
2525 STACK[STKPTR + 1].DES.CHARVAL := '@';
2526
2527 (* <QUALIFICATION> ::= IF <EXPRESSION> *)
2528 BEGIN
2529   STACK[STKPTR - 1].DES.CHARVAL := 'Q';
2530   IF STACK[STKPTR].EXPTYPE <> BOOL THEN
2531     ERROR(26, 1, -1);
2532   POPEVALSTACK(OPSTORE[1], SELSTORE[1]);
2533   NEWLABEL(OPSTORE[2]);
2534   PUTS('jmpf', 2, 1);
2535   STACK[STKPTR - 1].DES.SYMNAM := OPSTORE[2]
2536 END;
2537
2538 (* <EPISODE TIMING> ::= / : <ROE> /
2539 : <ROE> , <B1> / : <ROE> , <B1> , <B2> /
2540 : <ROE> , <B1> , <B2> , <RANK> *)
2541 BEGIN
2542   FOR I := 1 TO 5 DO
2543     SELSTORE[I] := 0;

```



```

2544 CASE PRODUCTION OF
2545 162 : SELSTORE[1] := STACK[STKPTR].DES.INTVAL;
2546 163 : BEGIN
2547 164 : SELSTORE[1] := STACK[STKPTR - 2].DES.INTVAL;
2548 SELSTORE[2] := STACK[STKPTR].DES.INTVAL
2549 END;
2550 165 : BEGIN
2551 SELSTORE[1] := STACK[STKPTR - 4].DES.INTVAL;
2552 SELSTORE[2] := STACK[STKPTR - 2].DES.INTVAL;
2553 SELSTORE[3] := STACK[STKPTR].DES.INTVAL
2554 END;
2555 166 : BEGIN
2556 SELSTORE[1] := STACK[STKPTR - 6].DES.INTVAL;
2557 SELSTORE[2] := STACK[STKPTR - 4].DES.INTVAL;
2558 SELSTORE[3] := STACK[STKPTR - 2].DES.INTVAL;
2559 SELSTORE[4] := STACK[STKPTR].DES.LINEPOS;
2560 SELSTORE[5] := STACK[STKPTR].DES.INTVAL
2561 END
2562 END
2563 END;
2564
2565
2566 167 : (*WHEN DO> ::= <QUALIFICATION> WHEN <NAME>
2567 <EPISODE TIMING> DO <TASK LIST> *)
2568
2569 BEGIN
2570 WITH STACK[STKPTR - 3].DES.SYMLOC DO
2571 CASE KIND OF
2572 UNDEFINED : ERROR(28,1,STACK[STKPTR - 4].DES.LINEPOS-CC+2);
2573 BINARY :
2574 FNCTN : IF TYPE8.SYMNAME <> 'BINARY' THEN
2575 ERROR(30,1,STACK[STKPTR-4].DES.LINEPOS-CC+2);
2576 OTHERWISE ERROR(30,1,STACK[STKPTR-4].DES.LINEPOS-CC)
2577 END;
2578 FOR I := 1 TO OPI DO
2579 PUTA(STACK[STKPTR-3].DES.SYMNAME,OPSTORE[I],5);
2580 IF STACK[STKPTR-5].DES.CHARVAL = 'Q' THEN
2581 BEGIN
2582 OPSTORE[1] := STACK[STKPTR-5].DES.SYMNAME;
2583 PUTS('loc',1,0);
2584 PUTSYM('LOC',1,0)
2585 END
2586 END;
2587
2588 168 : (* <SIMPLE DO> ::= <QUALIFICATION> DO <TASK LIST> <RANK>*)
2589
2590 BEGIN
2591 SELSTORE[1] := 0;
2592 FOR I := 1 TO OPI DO
2593 PUTA(' ',OPSTORE[I],5);
2594 IF STACK[STKPTR-3].DES.CHARVAL = 'Q' THEN
2595 BEGIN

```



```

2596 OPSTORE[1] := STACK[STKPTR-5].DES.SYMNAME;
2597 PUTS('loc
2598 ',1,0)
2599 END
2600 END;
2601
2602 169, (* <EVERY> ::= <QUALIFICATION> EVERY <ROE>
2603 DO <TASK LIST> *)
2604
2605 170 : (* <AT TIME> ::= <QUALIFICATION> AT <TIME>
2606 DO <TASK LIST> *)
2607
2608 BEGIN
2609 SELSTORE[1] := STACK[STKPTR-2].DES.INTVAL;
2610 FOR I := 1 TO OPI DO
2611 PUTA('
2612 ',OPSTORE[I],5);
2613 IF STACK[STKPTR - 3].DES.CHARVAL = 'Q' THEN
2614 BEGIN
2615 OPSTORE[1] := STACK[STKPTR - 5].DES.SYMNAME;
2616 PUTS('loc
2617 ',1,0)
2618 END
2619 END;
2620
2621 171 : (* <TASK LIST> ::= <NAME> *)
2622
2623 BEGIN
2624 WITH STACK[STKPTR].DES.SYMLOC DO
2625 CASE KIND OF
2626 UNDEFINED : ERROR(28,1,-1);
2627 TASK : ;
2628 FNCTN : ;
2629 OTHERWISE ERROR(34,1,-1)
2630 END;
2631 OPSTORE[1] :=STACK[STKPTR].DES.SYMNAME;
2632 OPI := 1
2633 END;
2634
2635 172 : (* <TASK LIST> ::= <TASK LIST> THEN <NAME> *)
2636
2637 BEGIN
2638 WITH STACK[STKPTR].DES.SYMLOC DO
2639 CASE KIND OF
2640 UNDEFINED : ERROR(28,1,-1);
2641 TASK : ;
2642 FNCTN : ;
2643 OTHERWISE ERROR(34,1,-1)
2644 END;
2645 OPI := OPI + 1;
2646 OPSTORE[OPI] := STACK[STKPTR].DES.SYMNAME
2647 END;
2648
2649 182 : (* <DESIGN CRITERIA> ::= DESIGN CRITERIA
2650 METRIC <METRIC> ; VOLUMES <NUMBER LIST> ;

```



```

2649 MONITORS <NUMBER LIST> ; *)
2650
2651 BEGIN
2652   PUTD(STACK[STKPTR-7].DES.SYNAME,STACK[STKPTR-4].DES.INTVAL,
2653   STACK[STKPTR-1].DES.INTVAL-STACK[STKPTR-4].DES.INTVAL);
2654   NLI := 0
2655   END;
2656
2657 183,184,185 : (* <METIRC> ::= FIRST/COST/POWER *);
2658
2659 190 : (* PRINT ALL CONSTANTS USED DURING COMPILATION *)
2660
2661 BEGIN
2662   PUTT(' SYSTEM ');
2663   FOR I := 1 TO CSI DO
2664     BEGIN
2665       OPSTORE[I] := CONSTANTSTORE[I].NAME;
2666       SELSTORE[I] := CONSTANTSTORE[I].VAL;
2667       SELSTORE[2] := CONSTANTSTORE[I].PRECISION;
2668       PUTS('cons',1,2);
2669       PUTSYM('CONS',1,2)
2670     END;
2671   PRINTemps
2672   END;
2673
2674 END (*CASE PRODUCTION OF *)
2675 END; (* PROCEDURE SEMANTIC1 *)
2676
2677 BEGIN (*MAIN*)
2678
2679 INITIALIZE;
2680 PUTT(' SYSTEM ');
2681 PUTS('MAIN',0,0);
2682 PARSE;
2683
2684 (*THE BELOW STMTS CHECK TO SEE IF TOGGLES HAVE*)
2685 (*BEEN TURNED ON TO TRACE THE PARSE EXECUTION *)
2686 (*AND CALLS THE PROCEDURE TO PRINT THE DETAILS*)
2687
2688 99: IF LINERRPTR <> 0 THEN PRINTLINERRORS;
2689   IF PROGRAMERRFLAG THEN PRINTERRORS;
2690   IF SWITCH[PRINTTABLE] THEN GOPRINTTABLE
2691   END.

```


APPENDIX E

SCRATCH PAD EXAMPLE

PAGE 1

```

CSDL TRANSLATOR
NAVAL POSTGRADUATE SCHOOL
18-APR-1981 17:03.1
1 -- PRINTTABLE
2
3 IDENTIFICATION
4
5 DESIGNER : "ALAN ROSS"
6 DATE : "12-28-83"
7 PROJECT : "DUAL PROCESS CONTROL APPLICATION"
8
9 DESIGN CRITERIA
10
11 METRIC FIRST ;
12 VOLUMES 8 ;
13 MONITORS 8 ;
14
15
16 ENVIRONMENT
17
18 INPUT : CONST,8,TTL ; CONST,8,TTL ; FLGA,1,TTL ;
19 PINA,8,TTL ; FLGB,1,TTL ;
20 PINB,8,TTL ; END INPUT ;
21
22 OUTPUT : VA,8,TTL ; VB,8,TTL ; END OUTPUT ;
23
24 ARITHMETIC : KCA,8 ; KCB,8 ; CNTB,8 ; ITIA,8 ; ITIB,8 ; AINT,8 ; TDA,8 ;
25 TDB,8 ; BINT,8 ; VSA,8 ; VSB,8 ; BDIFF,8 ; PSA,8 ; PSB,8 ; CONPTT,8 ;
26 EA,8 ; EB,8 ; KP1A,8 ; EA1,8 ; EA2,8 ; EB1,8 ; EB2,8 ; KP1B,8 ;
27 END ARITHMETIC ;
28
29
30 PROCEDURES
31
32 FUNCTION DATAA:
33   BINARY ,1;
34   SENSE (FLGA);
35   IF FLGA = 1 THEN DATAA := 1; END IF ;
36   END DATAA ;
37
38 FUNCTION DATAB:
39   BINARY ,1;
40   SENSE (FLGB);
41   IF FLGB = 1 THEN DATAB := 1; END IF ;
42   END DATAB ;
43
44 FUNCTION BCNT :
45   BINARY ,1 ;
46   IF CNTB >= 4 THEN BCNT := 1; END IF ;
47   END BCNT ;
48
49 TASK AFIX ;
50   ARITHMETIC : ADIFF,8 ; END ARITHMETIC ;

```



```

1 CSDL TRANSLATOR
2 NAVAL POSTGRADUATE SCHOOL
3 18-APR-1981 17:03.1
4
51 SENSE (PINA);
52 EA := PINA*KCA - PSA;
53 ADIFF := (3*EA - 4*EA1 + EA2) *5;
54 AINT := AINT + EA/KCA;
55 VA := VSA + KCA*(EA + ITIA* AINT + TDA*ADIFF);
56 ISSUE (VA);
57 DATAA := 0;
58 EA2 := EA1;
59 EA1 := EA;
60 END AFIX;
61
62 TASK BCALC;
63 SENSE (PINB);
64 EB := PINB*KCB - PSB;
65 BDIFF := (3*EB - 4*EB1 + EB2)*10;
66 BINT := BINT + EB/KCB;
67 CNTB := CNTB + 1;
68 DATAB := 0;
69 END BCALC;
70
71 TASK BFIX;
72 CNTB := 0;
73 VB := VSB + KCB*(EB + ITIB*BINT + TDB*BDIFF);
74 ISSUE (VB);
75 END BFIX;
76
77 FUNCTION CONFLG;
78 BINARY, 1;
79 SENSE (CONSN);
80 IF CONSN > 0 THEN CONFLG := 0; END IF;
81 END CONFLG;
82
83 TASK CHGCON;
84 SENSE (CONST);
85 IF CONPTT = 1 THEN KCA := CONST; END IF;
86 IF CONPTT = 2 THEN ITIA := 1/CONST; END IF;
87 IF CONPTT = 3 THEN TDA := CONST; END IF;
88 IF CONPTT = 4 THEN VSA := CONST; END IF;
89 IF CONPTT = 5 THEN PSA := CONST; END IF;
90 IF CONPTT = 6 THEN AINT := CONST; END IF;
91 IF CONPTT = 7 THEN KCB := CONST; END IF;
92 IF CONPTT = 8 THEN ITIB := 1/CONST; END IF;
93 IF CONPTT = 9 THEN TDB := CONST; END IF;
94 IF CONPTT = 10 THEN VSB := CONST; END IF;
95 IF CONPTT = 11 THEN PSB := CONST; END IF;
96 IF CONPTT = 12 THEN BINT := CONST; END IF;
97 END CHGCON;
98
99

```


100 CONTINGENCY LIST

PAGE 3

```

1 CSDL TRANSLATOR
  NAVAL POSTGRADUATE SCHOOL
  18-APR-1981:17:03.1
101 WHEN DATA: 100 MS DO AFIX;
102 WHEN DATAB: 50 MS DO BCALC;
103 WHEN BCNT: 100 MS DO BFIX;
104 WHEN CONFLG DO CHGCON;
105
106 END

1 FUNCTION RESWD 48
2 DATAB FUNCTION BINARY 1
  M RESWD 57
3 DESIGN RESWD 36
4
5
6 THEN RESWD 72
7 PROJECT RESWD 67
8
9 BCNT FUNCTION BINARY 1
  TERM RESWD 71
10 DATA FUNCTION BINARY 1
  FOR RESWD 46
  ARITHMETIC RESWD 25
11 AND RESWD 24
12 PRINTTABLE UNDEFINED
13 EA ARITHMETIC 8 0
  VSB ARITHMETIC 8 0
14 EBCDIC RESWD 40
  CODE RESWD 31
15 CHGCON TASK
  VSA ARITHMETIC 8 0
  VOLUMES RESWD 78
  MS RESWD 60
16
17 UNTIL RESWD 75
18 KCB ARITHMETIC 8 0
  TTL RESWD 74

```


19	TASK POWER ISSUE	RESWD RESWD RESWD	70 65 55	
	KCA	ARITHMETIC	8	0
	AT	RESWD	28	
20	BINT	ARITHMETIC	8	0
	PINB	TRANSDC INPUT		TTL
	PINA	TRANSDC INPUT		TTL
	WHILE	RESWD	81	
	CONTINGENC	RESWD	32	
21	TDB	ARITHMETIC	8	0
	WHEN	RESWD	80	
	EVERY	RESWD	44	
	BINARY	RESWD	30	
22	TDA	ARITHMETIC	8	0
23	BDIFF	ARITHMETIC	8	0
	IIL	RESWD	52	
	BCD	RESWD	29	
24	EB	ARITHMETIC	8	0
25	CONSN DATE	TRANSDC INPUT RESWD	35	TTL
26	AFIX TO	TASK RESWD	73	
27	ECL	RESWD	41	
28	VA LIST	TRANSDC OUTPUT RESWD	56	TTL
29				
30	NOT	RESWD	61	
31	METRIC IN	RESWD RESWD	58 53	
32	IDENTIFICA	RESWD	50	
33	S	RESWD	68	
34	DO	RESWD	38	
35	CNTB MONITORS	ARITHMETIC RESWD	8 59	0
36	FIRST	RESWD	45	

37	DUPLEX	RESWD	39		
	PSB	ARITHMETIC	8	0	
	ENVIRONMEN	RESWD	43		
	ASCII7	RESWD	27		
	ASCII6	RESWD	26		
38	CONPTT	ARITHMETIC	8	0	
	PSA	ARITHMETIC	8	0	
	ITIB	ARITHMETIC	8	0	
	ITIA	ARITHMETIC	8	0	
	CONST	TRANSDC INPUT		TTL	8
	US	RESWD	76		
	NS	RESWD	62		
39	VB	TRANSDC OUTPUT		TTL	8
	OUTPUT	RESWD	64		
40	PROCEDURES	RESWD	66		
41	KPIB	ARITHMETIC	8	0	
	KPIA	ARITHMETIC	8	0	
	DESIGNER	RESWD	37		
42	EA2	ARITHMETIC	8	0	
43					
44	EA1	ARITHMETIC	8	0	
45					
46					
47	FLGB	TRANSDC INPUT		TTL	1
	FLGA	TRANSDC INPUT		TTL	1
	WAIT	RESWD	79		
	FROM	RESWD	47		
	COST	RESWD	33		
48					
49	BFIX	TASK			
	BCALC	TASK			
	H	RESWD	49		
50	VARIABLES	RESWD	77		
	SENSE	RESWD	69		
	END	RESWD	42		
51	AIN	ARITHMETIC	8	0	
	OR	RESWD	63		
52	IF	RESWD	51		
53	CONFLG	FUNCTION		BINARY	1
	EB2	ARITHMETIC	8	0	

54	CRITERIA	RESWD	34	
	ADIFF	ARITHMETIC	8	0
	EB1	ARITHMETIC	8	0
	INPUT	RESWD	54	

APPENDIX F SYMBOL TABLE

S. INPUTPORT(CONSIN,TTL:8)	
S. INPUTPORT(CONST,TTL:8)	
S. INPUTPORT(FLGA,TTL:1)	
S. INPUTPORT(PINA,TTL:8)	
S. INPUTPORT(FLGB,TTL:1)	
S. INPUTPORT(PINB,TTL:8)	
S. OUTPUTPORT(VA,TTL:8)	
S. OUTPUTPORT(VB,TTL:8)	
S.VARIABLE (KCA:8,0)	
S.VARIABLE (KCB:8,0)	
S.VARIABLE (CNTB:8,0)	
S.VARIABLE (ITIA:8,0)	
S.VARIABLE (ITIB:8,0)	
S.VARIABLE (AINT:8,0)	
S.VARIABLE (TDA:8,0)	
S.VARIABLE (TDB:8,0)	
S.VARIABLE (BINT:8,0)	
S.VARIABLE (VSA:8,0)	
S.VARIABLE (VSB:8,0)	
S.VARIABLE (BDIFF:8,0)	
S.VARIABLE (PSA:8,0)	
S.VARIABLE (PSB:8,0)	
S.VARIABLE (COMPTT:8,0)	
S.VARIABLE (EA:8,0)	
S.VARIABLE (EB:8,0)	
S.VARIABLE (KPIA:8,0)	
S.VARIABLE (EA1:8,0)	
S.VARIABLE (EA2:8,0)	
S.VARIABLE (EB1:8,0)	
S.VARIABLE (EB2:8,0)	
S.VARIABLE (KPIB:8,0)	
S.VARIABLE (@01:)	
S.LOC (@02:)	
S.LOC (@03:)	
S.VARIABLE (ADIFF:8,0)	
S.LOC (@04:)	
S.LOC (@05:)	
S.LOC (@06:)	
S.LOC (@07:)	
S.LOC (@08:)	
S.LOC (@09:)	
S.LOC (@10:)	
S.LOC (@11:)	
S.LOC (@12:)	
S.LOC (@13:)	
S.LOC (@14:)	
S.LOC (@15:)	
S.LOC (@16:)	
S.CON (C01:1,8)	
S.CON (C02:4,8)	
S.CON (C03:3,8)	
S.CON (C04:5,8)	
S.CON (C05:0,8)	

S. CONS
S. CONS
S. CONS
S. CONS
S. CONS
S. CONS
S. CONS
S. CONS

(@C06:10,8)
(@C07:2,8)
(@C08:6,8)
(@C09:7,8)
(@C10:8,8)
(@C11:9,8)
(@C12:11,8)
(@C13:12,8)

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